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DU MONT

CATHODE-RAY OSCILLOGRAPHS

Types 329-A and 323

329A

NOTE

Because of design modifications, the type designation of the Type 329 has been changed to Type 329-A. All references to the Type 329 in this manual pertain to the Type 329-A.

Allen B. Du Mont Laboratories, Inc.

INSTRUMENT DIVISION

760 BLOOMFIELD AVENUE, CLIFTON, N. J., U. S. A.

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Obviously, the design of any scientific instrument results from a series of compromises which represent the designer's opinion of an ideal instrument consistent with contemporary engineering techniques and present-day production possibilities.

In developing this instrument, an attempt has been made to incorporate those characteristics which, we believe, will satisfy the greatest number of applications.

We feel, however, that the real test of any instrument is the opinion of the man who uses it. This day-to-day test of the instrument's advantages and limitations will prove, more than any other method, just what characteristics are desirable.

Because of the nature of the equipment manufactured by Allen B. Du Mont Laboratories, Inc., it is only by complete cooperation between the customer and our Engineering Department that satisfactory designs can be achieved. In a continuous attempt to increase the applicability of our equipment to the problems of the engineer, we sincerely request suggestions advising in what manner the design of this equipment may be further extended to include these problems.

DU MONT

CATHODE-RAY OSCILLOGRAPHS

Types 329-A and 323

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Because of design modifications, the type designation of the Type 329 has been changed to Type 329-A. All references to the Type 329 in this manual pertain to the Type 329-A.

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INSTRUMENT DIVISION

760 BLOOMFIELD AVENUE, CLIFTON, N. J., U. S. A.

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ALLEN B. DU MONT LABORATORIES, INC.
Instrument Division
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Schematics attached inside of rear cover. Parts Lists appear on reverse sides of schematics.

FIGURE 1-1. DUMONT TYPE 329-A CATHODE-RAY OSCILLOGRAPH

section 1
general description

The Du Mont Types 329 and 323 cathode-ray oscillograph are precision, wide-band, quantitative instruments, designed to operate over the present wide range of general-purpose oscillography—from very-low-speed, mechanical applications to high-speed single transients and pulse waveforms. The two instruments are essentially identical except for the cathode-ray tube and accelerating potential employed which, in the Type 329, provides greater pattern brilliance for adequate display of signals of low repetition rate and for single, high-speed transients. Performance specifications for both instruments are set forth in Table 1-1. Facilities provided can best be appreciated by referring to the over-all block diagram, Figure 1-2.

The frequency range of the vertical amplifier in the Types 329 and 323 extends from d-c to 10 mc. The range of calibrated linear sweeps, continuously variable in writing rate from 1 second to 0.1 microsecond per major scale division, has been carefully selected to assure useful presentation of any signal within the frequency-handling capabilities of the instrument.

An unusual feature of these instruments is the new linear Du Mont calibrated "notched" sweep, which provides for instant expansion of portions of the sweep trace by factors of 5 or 10, depending upon writing rate. The notch, which encompasses two major scale divisions, may be moved along the sweep trace, thus selecting the desired portion for expansion. This expanded portion may be examined in detail while visibly observing its relationship to the remainder of the trace.

Accurate signal measurements of both time and voltage may be readily obtained. Calibration of the linear sweep-writing rate may be determined directly from front-panel controls, while voltage measurements may be read directly from the illuminated scale, calibrated by an accurate square-wave standard.

Features in the Types 329 and 323 include driven or recurrent sweep operation with forward trace brightening, provision for Z-axis (intensity) modulation, sweep gate output signal for operating associate equipment, dual vertical input terminals, variable scale illumination for use in photographic recording, and convenient switching from 115-volt to 230-volt, 50-60 cycle line operation. Also, specially featured are new mono-accelerator, high-resolution, tight-tolerance cathode-ray tubes. Owing to their unique electron gun and accelerating systems, geometric distortion is greatly reduced and may be virtually ignored in most exacting applications. Excellent spot size, focus and pattern brilliance will be readily apparent.

Trace stability is essentially "rock bound" through liberal use of regulated d-c and heater voltages.

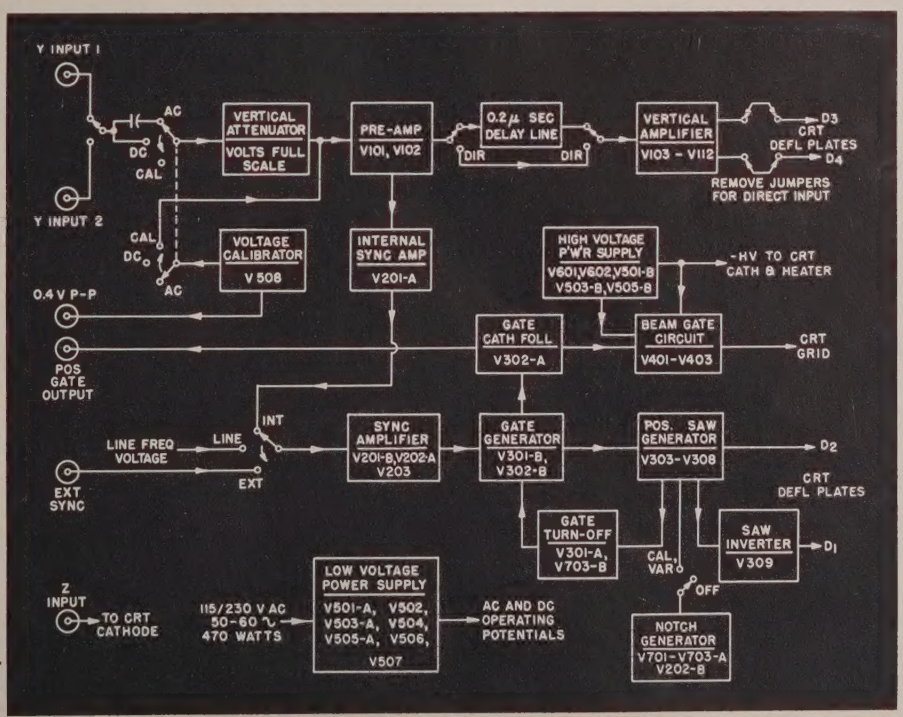


FIGURE 1-2. FUNCTIONAL BLOCK DIAGRAM OF TYPES 329 AND 323. CATHODE-RAY OSCILLOGRAPHS. EXCEPT FOR CATHODE-RAY-TUBE TYPES AND ACCELERATING POTENTIALS, THE TYPES 329 AND 323 ARE SIMILAR. SEE TABLE 1-1 FOR SPECIFIC DIFFERENCES.

section 1
general description

TABLE 1-1
PERFORMANCE CHARACTERISTICS
TYPES 329 AND 323 CATHODE-RAY OSCILLOGRAPHS

	329	323
CATHODE-RAY TUBE		
Type	5ATP–	5AMP–
Total Accelerating Potential	6000 volts	2500 volts
CRT Scale	Engraved illuminated scale over face of tube; illumination control provided on front panel	
	1 major scale division = 0.70 inches	1 major scale division = 1.0 inch
VERTICAL DEFLECTION CIRCUIT		
Input Coupling	A-C or D-C signals to *either* or *both* Y input connectors	
Isolation Between Y INPUTS	50 db unterminated, or greater than 70 db with 50 ohm termination	
Input Voltage	500 (dc plus peak ac) maximum	
Input Impedance		
Amplifier	2.0 megohms ±2%, 60 μμf, max.	
Direct-single ended	6.5 μμf, max.	
Direct-balanced	5 μμf, max.	
Input Attenuation	Provided by a 2% 11 step R-C compensated attenuator corresponding to full-scale input voltages of 0.2, 0.4, 1, 2, 4, 10, 20, 40, 100, 200, and 400 volts ±5%	
Deflection Factor		
Amplifier	0.2 volts peak-to-peak for full scale deflection (2 major scale divisions). Optional HIGH GAIN (approx. 0.1 volt peak-to-peak for full-scale deflection) is available.	
Direct	34–42 peak-to-peak volts/inch	20-25 peak-to-peak volts/inch
Pulse Response (to a step function)		
Rise time	0.035 microseconds	
Overshoot	2% maximum	
Decay at top		
Direct coupled	2% of deflection	
Capacitively coupled	10% of deflection in 8 milliseconds	
Sinusoidal Frequency Response (average value at 10 kc)		
Low-frequency response		
Direct coupled	Flat to dc	
Capacitively coupled	Down 10% at 10 cycles from average value. No more than 25% droop on a 20 cps square wave, or 10% on a 60 cps square wave	
High-frequency response		
Either type coupling	Down not more than 30% at 10 mc from the average value, nor more than 75% at 20 mc; no positive slope will occur in the characteristic above 10 kc. In the HIGH GAIN position, the response at 5 mc is down approximately 30%.	

TABLE 1-1 (Continued)

	329	323
Undistorted Deflection	Twice full scale deflection	
Vertical Positioning	So that any full scale portion of the undistorted deflection may be examined on screen	
Signal Delay	0.2 microseconds; signal may be fed through undelayed, if desired, by selecting Direct jacks provided	
Voltage Calibration		
Availability	To Vertical Amplifier by Y-INPUT SELECTOR in CAL position. To front-panel jack marked 0.4 V P-P	
Waveshape	Clipped sine wave	
Frequency	Power line	
Amplitude	0.2 volt peak-to-peak, ±2%, to Vert Amplifier 0.4 volt peak-to-peak, ±2%, to panel jack	
HORIZONTAL DEFLECTION CIRCUIT		
Linear-sweep Time Base		
Circuit	Vacuum tube sweep, driven or recurrent as desired	
Writing rate	Continuously variable over seven steps from 1 sec to 0.1 μsec/major scale division	
Maximum writing rate	7 inches/μsec	10 inches/μsec
Sweep length (minimum)	2.8 inches (4 major scale divisions)	4 inches (4 major scale divisions)
Time calibration		
Method	Calibrated 7 position range switch and vernier control (SWEEP MULTIPLIER—A and –B controls)	
Calibration units	μsec/major scale division	
Accuracy	Within ±5% of product of MULTIPLIER-A and MULTIPLIER-B dial readings	
Sweep linearity	Incremental linearity better than 5% (No 10% increment varies by more than 5% from any other 10% increment)	
Sweep expansion		
Type of expansion	Movable "notch" (available on all but fastest sweep range), either fixed CALibrated or VARiable uncalibrated	
Length of notch	Two major scale divisions ±10%	
Notch positioning	Starting point movable over first 2 major scale divisions by NOTCH POSITION control	
CALibrated notch writing rate	No notch on 0.1 step of MULTIPLIER-B; 0.2 ±5% x SWEEP RATE on 1.0 step; 0.1 ±5% x SWEEP RATE on other steps	
CALibrated notch linearity	No 20% interval varies more than 5% from any other 20% interval (not including the first and last minor divisions)	
VARiable rate notch expansion	Permits sweep expansion by as much as 150 times at low frequencies. At higher frequencies, maximum expansion approaches the value for CAL notch. No notch on 0.1 step of MULTIPLIER-B	

TABLE 1-1 (Continued)

	329	323
Sweep gating	Positive gate unblanks CRT during forward sweep only. Beam is not visible prior to triggering of the driven sweep	
Triggering and synchronization		
Sources	Positive or negative INTernal, EXTernal, or LINE-frequency signals	
Internal sync operation (Instrument set for Voltage Calibration)		
Sine wave vert. defl.		

Defl.	DRIVEN	RECURRENT
2 div.	40 cps to 2 mc	40 cps to 5 mc
5 div.	20 cps to 3 mc	20 cps to 20 mc
10 div.	10 cps to 4 mc	10 cps to 30 mc

Sawtooth vert. defl.	DRIVEN sweep will trigger if slope is greater than 1 div/millisecond (20 volts/second)
External sync operation	
Input voltage	500 volts (dc + peak ac) maximum

Sine wave sync signal	RMS Volts	DRIVEN	RECURRENT
	0.1V	50 cps to 2 mc	50 cps to 10 mc
	0.2V	40 cps to 3 mc	40 cps to 20 mc
	1.0V	20 cps to 5 mc	20 cps to 30 mc

Sawtooth sync signal	DRIVEN sweep will trigger if slope is greater than 50 volts/second and duration is more than 0.025 microsecond
Horizontal Positioning	±3 scale divisions
INTENSITY MODULATION CIRCUIT	
Availability	Front panel connector (BNC for 93 ohm cable)
Input Impedance	12,000 ohms, 70 μμf. (An internal connection is provided at the top of the instrument to reduce input capacity to 25 μμf)
Polarity	Positive signals decrease beam intensity; +15 volts peak will blank beam with normal INTENSITY control setting
POWER SUPPLY	
Primary-power Potential	115/230 volts ±10%
Primary-power Frequency	50-60 cycles
Primary Power	440 watts
Fuse Protection	
115 volt operation	5 amperes, slow-blow
230 volt operation	3.2 amperes, slow-blow

High voltage supply	1/16 ampere	1/32 ampere

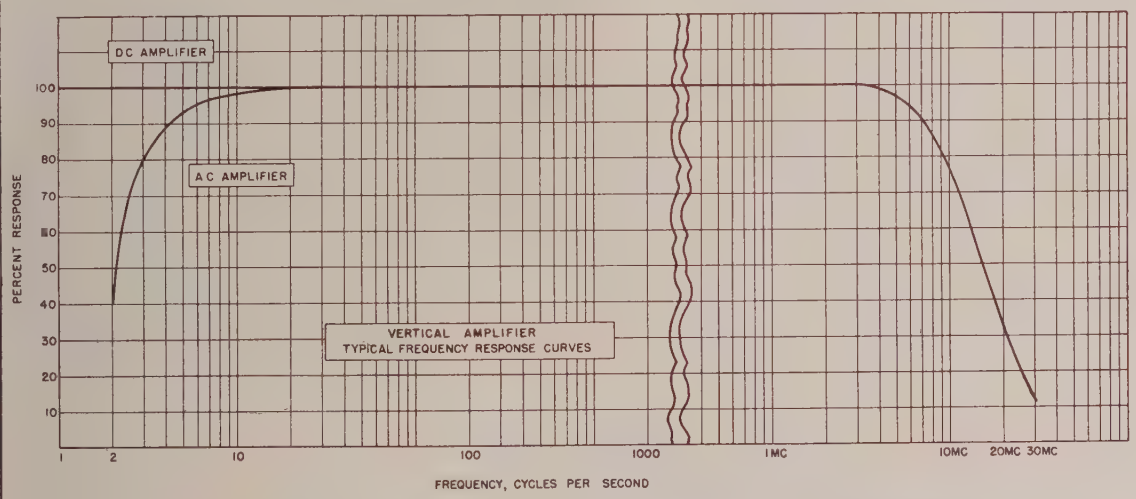
TABLE 1-1 (Continued)

PHYSICAL CHARACTERISTICS

Height	17-1/2 inches over-all
Width	12-3/8 inches over-all
Depth	22-1/2 inches over-all
Weight	70 pounds

TUBE COMPLEMENT – TYPES 329 and 323

1–1X2-A	4–6485/6AH6K	1–6CL6	6–12AT7
2–5651	3–6AL5	1–6J6	1–12AU7
1–5894/AX-9903	2–6AU5	10–6U8	2–12AW6
1–5ATP–(329)	1–6AU6	2–6080	2–12BY7
5AMP–(323)	1–6BC7		
11			



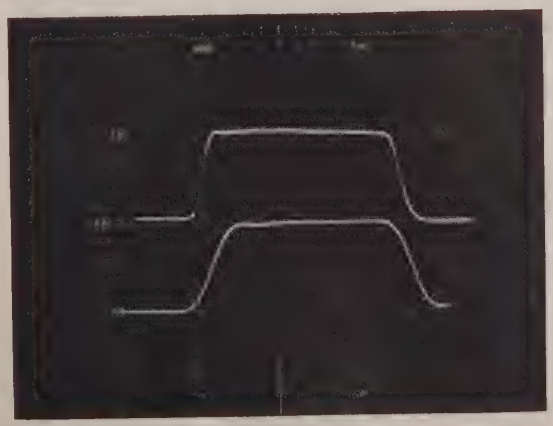
VERTICAL AMPLIFIER TYPICAL FREQUENCY RESPONSE CURVES

TYPICAL VERTICAL AMPLIFIER PULSE RESPONSE

Top Trace—0.25 usec pulse, direct to deflection plates

Bottom Trace—0.25 usec pulse, passed through vertical amplifier

Sweep Rate—0.1 usec/major scale division for both traces



section 2
operation

— Warning —

Potentials as high as 6000 volts are employed in the Type 329 and 2500 volts in the Type 323. Such voltages are extremely dangerous; and every possible safety precaution should be taken to avoid contact with them. The instrument is not a hazard when enclosed in its cabinet (provided the side-panel door is closed). It should not be operated outside the cabinet except for purposes of adjustment or repair, at which times precautions should be taken as described in Section IV, Maintenance.

1. Unpacking, Inspection and Installation

The Du Mont Types 329 and 323 Cathode-ray Oscillographs are shipped with all tubes in place and ready to operate. The shock mounted vertical amplifier chassis is prevented from moving during transit by means of a wire tiedown. Upon receipt, and prior to operation, this must be removed and the instrument inspected for any damage incurred in shipment. To slide the chassis out of the cabinet, remove the two 6-32 screws at the lower rear and the 1/4-20 screw in the center rear of the cabinet.

Since these instruments are portable, no special installation procedure is required. Normally the oscillograph may be placed where most convenient for viewing while at the same time maintaining short signal leads. Although shielding has been provided, operation in very strong fields may cause spurious deflections and should be avoided. Re-orientation or additional shielding of the instrument may be necessary to minimize the effects of such fields.

The instruments are shipped for operation from a 50-60 cycle, single-phase, 115-volt power source and will operate satisfactorily with line-voltage variations of $\pm 10\%$. To change to 230 volt operation, see Section IV, Maintenance. Where line-voltage variations are excessive, it is suggested that a constant-voltage transformer of suitable power rating be employed in the power line to the instrument.

2. Precaution Against Screen Burning

A sharply focused spot of high intensity and small area should not be permitted to remain stationary on the screen for any length of time. Under such conditions, the entire beam energy is concentrated over a small area, thus subjecting the screen material to burning and discoloration. This condition is most likely to exist when using the DRIVEN mode of sweep operation and with the INTENSITY turned up with no signal input. Extreme caution must be employed in the Type 329 to prevent this condition from occurring. Always keep the INTENSITY low and never allow a spot to remain stationary on the screen.

TABLE 2-1
PRELIMINARY CONTROL SETTINGS

CONTROL	POSITION
Y POSITION, X POSITION	center of range
INTENSITY	fully CCW
FOCUS	center of range
Y INPUT SELECTOR	CAL
VOLTS FULL SCALE	400
Y CAL ADJ (Y GAIN)	near maximum CW
SYNCHRONIZATION	
(SELECTOR)	INT
(AMPLITUDE)	center of range
SWEEP MODE	RECUR
MODE ADJ	center of range
SWEEP MULTIPLIER-B	10K
SWEEP MULTIPLIER-A	2.5
NOTCH	OFF
SYNC SHAPER	OUT

3. Energizing the Equipment

To place the instrument in operation for the first time, proceed as follows: Plug the power cord into the line outlet and throw the front-panel toggle switch to the POWER ON position. Allow approximately three minutes for the instrument to warm-up; in the meantime, set the various controls as indicated in Table 2-1.

Rotate the INTENSITY control clockwise to obtain a trace having normal brightness and set the FOCUS control for best definition. Because of the self-focus quality of the CRT employed in the Type 329, the FOCUS control may have very little effect on definition. Rotate the SYNCHRONIZATION (AMPLITUDE) control in either direction to lock the pattern, depending upon whether it is desired to have the start of the trace positive or negative going. Center waveform on screen vertically with Y POSITION control. Six cycles of the square wave calibrator waveform should be present in four major scale divisions of the screen; if not, the SWEEP CAL (Service) ADJustment should be reset. CAUTION: *Before making this or any other service adjustment, a 15 minute warm-up period is necessary for the circuits to completely stabilize.*

4. Controls and Terminals

a. GENERAL

The markings on the front panel adjacent to each control are essentially self explanatory,

TABLE 2-2
TABLE OF OPERATING CONTROLS AND TERMINALS

NAME OF CONTROL OR TERMINAL	REFERENCE SYMBOL	FUNCTION
Y POSITION	R129	Positions the trace vertically
Y POS BAL	R132	Positions the trace in the center of the screen with the Y POSITION control in the center of its range and the Y CAL ADJ at its maximum clockwise position
X POSITION	R375	Positions the trace horizontally
INTENSITY	R408	Varies the trace brightness
FOCUS	R410	Adjusts the trace sharpness
Y INPUT SELECTOR	S101	Couples A-C or D-C signals from either Y INPUT jack to the VOLTS FULL SCALE switch or the CALibrator signal to the vertical amplifier input stage
VOLTS FULL SCALE	S102	Selects input voltage range for full scale deflection (two major scale divisions)
NORMAL/HIGH GAIN	S103	Permits an optional increase in sensitivity of approximately 2-1 (switch in HIGH GAIN position).
Y CAL ADJ (Y GAIN)	R140	Sets the gain of the vertical amplifier to provide full scale deflection with the CALibrator signal applied; and allows for adjustment of pattern to convenient amplitude on screen for rise-time measurements, etc.
Y D-C BAL	R128	When properly adjusted, prevents vertical movement of the trace when the Y CAL ADJ control is varied
SYNCHRONIZATION (SELECTOR)	S201	Selects sweep synchronizing signals (INT, LINE, EXT 10:1, EXT 1:1)

TABLE 2-2 (Continued)
TABLE OF OPERATING CONTROLS AND TERMINALS

NAME OF CONTROL OR TERMINAL	REFERENCE SYMBOL	FUNCTION
SYNCHRONIZATION (AMPLITUDE)	R215	Selects phase and varies amplitude of the sweep synchronizing voltage
SYNC SHAPER switch	S202	Permits differentiation of sync signal for high frequency work if desired
SWEEP MODE	S301	Selects sweep circuit mode of operation (DRIVEN, RECURrent or RECURrent HI-FREQ)
MODE ADJ	R310-A	Determines sync clipping level for DRIVEN sweep operation
	R310-B	Varies the bias of gate circuit to make the sweep free running in the RECURrent modes of operation
SWEEP MULTIPLIER-A	R361	Provides continuous calibrated variation of sweep writing rate between steps of coarse sweep speed switch (MULTIPLIER-B)
SWEEP MULTIPLIER-B	S302	Provides decade stepped variation of sweep writing rate
NOTCH switch	S303	Selects either linear unexpanded sweep or notch sweep (CALibrated or VARiable)
NOTCH POSITION	R724-A	Moves the notch along the sweep to any desired point
NOTCH VARIABLE RATE	R724-B	Provides variable notch writing rate (uncalibrated) when the NOTCH switch is in the VAR position
SCALE	R541	Turns on the CRT scale lamps and varies illumination level
POWER ON	S501	Applies primary power to the instrument
Y INPUT 1 Y INPUT 2	J101 J102	Provide for connection of external signals to the Y INPUT SELECTOR switch
Z INPUT	J401	Provides for connection of external signals for intensity modulation of the trace
EXT SYNC	J201	Provides for connection of external synchronizing signals to the EXT positions of the SYNCHRONIZATION (SELECTOR) switch
POS GATE OUTPUT	J301	Provides positive gate output for operation of auxiliary equipment
		Provide connections to chassis ground

and after carefully studying Table 2-2, which lists the function of the various controls and terminals, the operator should find it possible to master the controls with a minimum of experimentation. Detailed instructions on operating the controls to make use of all the features of the instrument, are given in subsequent paragraphs.

b. SWEEP OPERATION

The horizontal sweep may be operated in any of three different modes, as selected by the SWEEP MODE switch—DRIVEN, RECURrent and RECURrent HI-FREQ.

The DRIVEN mode, which should be used for the majority of applications, is always employed when viewing random or aperiodic signals or periodic signals of low repetition rates, such as found in pulse work. If, when viewing a pulse on DRIVEN sweep, insufficient baseline is visible ahead of the pulse, the instructions given in paragraph 5 for making rise time measurements should be employed.

If desired, the RECURrent and RECURrent HI-FREQ modes may be employed when repetitive functions are to be studied. In most of these cases, RECUR mode will be satisfactory; however the RECUR mode circuits have an upper frequency limit of about 5 mc. For higher frequency synchronization, the RECUR HI-FREQ mode must be employed.

The sweep may be synchronized from any one of three sources selected by the SYNCHRONIZATION (SELECTOR) switch. In the INTernal position, the sync signal is derived from the Vertical Amplifier; in the LINE position, an internal source of line-frequency voltage provides the sync signal; and in the EXTernal positions, the sync signal comes from an external source connected to the EXT SYNC front-panel terminal. The external sync signal is attenuated 10:1 when the SYNCHRONIZATION selector is at the EXT 10:1 position only.

CAUTION

The SYNC SHAPER switch must be in the OUT position when using the CAL or low frequency (under 100 kc sine wave) signals. The shaping circuit is a high-pass filter which prevents sweep synchronization by low-frequency signals.

TABLE 2-3
INSTRUCTIONS FOR DRIVEN SWEEP OPERATION

1. INITIAL CONTROL SETTINGS	
FRONT-PANEL CONTROL	**DRIVEN SETTINGS**
SWEEP MODE	DRIVEN
MODE ADJ	fully CCW
SYNCHRONIZATION (SELECTOR)	INT, LINE or EXT as determined by signal source
(AMPLITUDE)	max ± as desired
INTENSITY*	center of range
FOCUS	center of range

2. PROCEDURE

a. Rotate the MODE ADJ control clockwise until a stable sweep appears. This is the optimum operating point; further clockwise rotation of the MODE ADJ control may result in erratic triggering because of excessive sync signal.

b. Adjust the INTENSITY and FOCUS controls to obtain the best trace.

*Note: Always keep intensity as low as possible on the Type 329

TABLE 2-4
INSTRUCTIONS FOR RECURRENT SWEEP OPERATION

1. INITIAL CONTROL SETTINGS	
FRONT-PANEL CONTROL	**RECUR AND RECUR HI-FREQ SETTINGS**
SWEEP MODE	RECUR OR RECUR HI-FREQ
MODE ADJ	fully CCW
SYNCHRONIZATION	
(SELECTOR)	INT, LINE or EXT as determined by signal source
(AMPLITUDE)	center of range (zero sync)
INTENSITY*	center of range
FOCUS	center of range

2. PROCEDURE

a. Rotate the MODE ADJ control clockwise until the sweep appears. The sweep is now free-running (recurrent). This step is done with Y SELECTOR switch on either AC or DC and no signal input.

b. Apply signal and adjust SWEEP MULTIPLIER-A and SWEEP MULTIPLIER-B to obtain the required number of cycles on screen and to stop pattern travel as much as possible.

c. Rotate SYNCHRONIZATION (AMPLITUDE) control in either direction to lock the pattern stationary. The direction chosen depends upon whether it is desired to have the start of the trace positive or negative going.

*Note: Always keep intensity as low as possible on the Type 329

The instructions, which follow, describe the methods of operating the sweep in the various modes.

(1) DRIVEN

In the DRIVEN mode of operation, the sweep is inoperative except when initiated by an incoming trigger or synchronizing signal. The MODE ADJ potentiometer is operated as a sync clipping level control to limit the sync voltage applied to the sweep circuit. Table 2-3 lists the control settings and adjustment procedure for driven-sweep operation:

Triggering of sweep may be accomplished with signals having repetition rates to at least 4 mc per second. For detailed requirements of triggering pulses, refer to Table 1-1.

(2) RECUR and RECUR HI-FREQ

In the RECURrent modes of operation, the sweep is made free-running by adjustment of the MODE ADJ control and synchronized to the waveform to be studied by means of the SYNCHRONIZATION controls. In the RECURrent mode, the sweep can be synchronized by signals in the frequency range from 5 cps to approximately 5 mc. For higher frequency synchronization (from approximately 5 mc to approximately 30 mc) the RECURrent HI-FREQ mode must be employed. If difficulty is encountered in the 5 mc region, the RECUR HI-FREQ position should be used. Below approximately 5 mc the RECUR HI-FREQ circuit will not provide good synchronization, and RECUR sweep should be used. The cross-over point, given as 5 mc, is an approximate value and may vary with different instruments. Table 2-4 lists the control settings and adjustment procedures for recurrent sweep operations.

c. NOTCH SWEEP OPERATION

Sweep expansion, in the form of a movable expanded sweep sector ("notch"), may be em-

ployed on the first six steps (100K, 10K, 1K, 100, 10 and 1.0) of the SWEEP MULTIPLIER-B switch. The calibrated writing rate multiplier in the "notch" is indicated on the front panel to the right of the NOTCH POSITION control. Thus, the "notch" rate may be determined directly from the writing rate of the unexpanded sweep and the multiplying factor. An uncalibrated variable rate "notch" is available by setting the NOTCH switch at VAR. To obtain the "notch" on screen, proceed as follows:

Step 1. Obtain the desired unexpanded sweep as outlined previously; then throw the NOTCH switch to either the CAL or VAR position depending whether a fixed calibrated or a variable rate "notch" is desired.

Step 2. Now, by rotating the NOTCH POSITION control clockwise, the "notch" will move from left to right and may be positioned over the portion of the waveform to be examined. Expansion will be variable or by a fixed factor of 10 or 5 depending upon the SWEEP MULTIPLIER-B and NOTCH switch positions used. The "notch" is not available on the 0.1 step of MULTIPLIER-B. The expansion factor of the variable rate notch may be as high as 150 at low frequencies (MULTIPLIER-B at 100K and 10K); but approaches the calibrated notch rate at high frequencies.

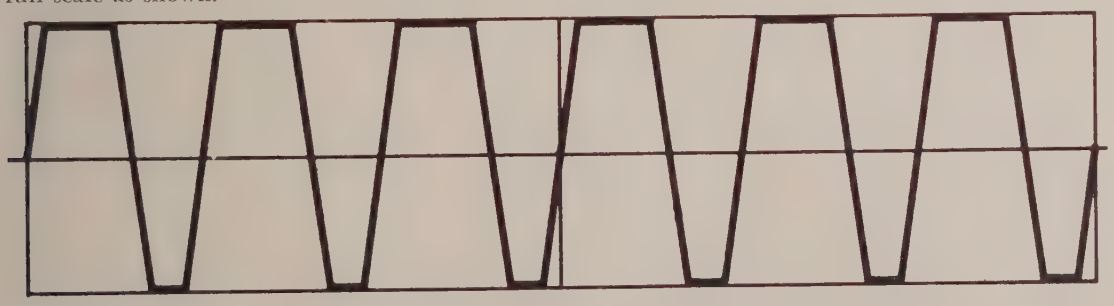
d. TIME (SWEEP) CALIBRATION

By means of the SWEEP MULTIPLIER-A and -B controls the operator can calibrate the sweep in microseconds-per-major-scale-division to an accuracy of $\pm 5\%$. This information is obtained directly from the front panel by taking the product (A $\times$ B) of the SWEEP MULTIPLIER-A and -B dial readings. To assure this accuracy throughout the life of the instrument,

CALIBRATION OF "SWEEP MULTIPLIER-A" AND "SWEEP MULTIPLIER-B" DIALS
(minimum warm up time 15 minutes)

CONTROL	POSITION
Y INPUT SELECTOR	CAL
SWEEP MODE	DRIVEN
SYNCHRONIZATION	INT or LINE
SWEEP MULTIPLIER-A	2.5
SWEEP MULTIPLIER-B	10K
SYNC SHAPER	OUT

Set SWEEP CAL ADJ so that 6 cycles of 60-cycles-per-second power-line frequency equals exactly full scale as shown.



FULL SCALE (FOUR MAJOR SCALE DIVISIONS)

NOTES:
1. If the primary power source is a 50-cycle line, set the SWEEP CAL ADJ to obtain five cycles of the calibration wave.
2. If desired, any accurate frequency source may be used to calibrate the MULTIPLIER controls, using the following formula:

$$AB = \frac{N \times 10^6}{4\ F}$$

where F = Frequency of calibrating source in cycles per second
N = Number of cycles or pulse intervals desired on a screen (full scale)
AB = Product of the SWEEP MULTIPLIER-A and -B dial readings

With a known F, choose a convenient number of cycles to be viewed on screen (quantity N in the formula). Solve the formula for the AB product and set the SWEEP MULTIPLIER dials accordingly. Then set the SWEEP CAL ADJ to present in exactly four major scale divisions on the screen the number of cycles (N) selected above. It must be remembered that the MULTIPLIER-A dial reading, calculated from the formula, must fall on one of the inscribed dial lines if interpolation errors are to be avoided.

a calibration adjustment is available entitled SWEEP CAL ADJ (accessible through the hole in the right side of the cabinet). When checking over-all sweep calibration and making this adjustment, refer to the plate mounted immediately above the access hole, or to the instructions which follow.

Calibration of controls at power-line frequency will normally provide a sufficiently high degree of accuracy, since power-line frequency is generally held accurate to ±0.5%, comparable to a finely focused spot on the screen. To calibrate, proceed as shown above.

e. OBTAINING VERTICAL DEFLECTION

(1) CHECKING AND SETTING POSITION BALANCE

If, after 15 minutes of warm-up time has elapsed, the trace shifts vertically as the Y CAL ADJ (Y GAIN) is rotated, the position balance should be readjusted in the following manner.

Step 1. Set the front-panel controls as follows:

CONTROL	INITIAL ADJUSTMENT
Y POSITION	center of range
VOLTS FULL SCALE	400
Y INPUT SELECTOR	D-C or A-C
Y CAL ADJ (Y GAIN)	fully CW
SWEEP MODE	RECUR
MODE ADJ	center of range
SYNCHRONIZATION (AMPLITUDE)	center of range (0)

Step 2. Remove signal from Y INPUT
Step 3. Obtain dim, finely focused trace
Step 4. With Y POS BAL, position trace to center vertically
Step 5. Turn Y CAL ADJ fully CCW; center trace with Y D-C BAL
Step 6. Turn Y CAL ADJ fully CW; recenter with Y POS BAL
Step 7. Turn Y CAL ADJ fully CCW; recenter with Y D-C BAL
Step 8. Repeat this procedure until trace no longer shifts as Y CAL ADJ (Y GAIN) is rotated

(2) CONNECTION OF SIGNAL TO VERTICAL CHANNEL

Signals to be observed are connected to the Vertical channel through the type BNC connectors labeled Y INPUT 1 and Y INPUT 2. A binding-post adaptor is provided for use when a type BNC connector is not available on the signal lead. The Y INPUT SELECTOR permits AC or DC coupling of either signal to the compensated attenuator (VOLTS FULL SCALE switch) or coupling of the CALibrating signal to the amplifier input stage. If desired, a signal may be connected direct to the cathode-ray tube vertical deflection plates (see paragraph 4 e (4) for details). Terminals for this purpose are provided inside the access door at the left side of the cabinet.

(3) VOLTAGE CALIBRATION (Y CALIBRATION)

By means of the VOLTS FULL SCALE switch and the Y CAL ADJ (Y GAIN) control, the cathode-ray tube scale may be calibrated to show amplitude of observed signals directly in volts (after a suitable warm-up period has elapsed). To facilitate amplitude measurements, the Y POS BAL and Y D-C BAL front-panel screwdriver adjustments should be properly set. However, the adjustment of these controls in no way affects calibration of the amplifier. To check and reset, if necessary, proceed as outlined in paragraph (1).

Turn the Y INPUT SELECTOR to CAL and rotate the Y CAL ADJ to obtain two major scale divisions of vertical deflection. (Position pattern vertically as required. The nature of the calibrating circuit results in a calibrating signal clamped at the top.) The instrument is now calibrated for voltage measurements, and the trace should be repositioned in order to observe the applied signal on screen. The setting of the VOLTS FULL SCALE switch will now determine the full scale (two major scale divisions) sensitivity of the instrument.

(4) SIGNAL DELAY

The Vertical Amplifier is provided with a signal delay of 0.2 μsec, which is sufficiently long to allow some baseline to appear ahead of the pulse under observation. If it is desired to make time comparisons of signals in the Y and Z axes as, for example, is done in computer work on coincidence circuits, the line may easily be removed from the circuit. To do this, remove the chassis from the cabinet as described in paragraph 1 of this section. Then move the two plugs, located at either end of the delay line chassis, to the DIRect pin jacks.

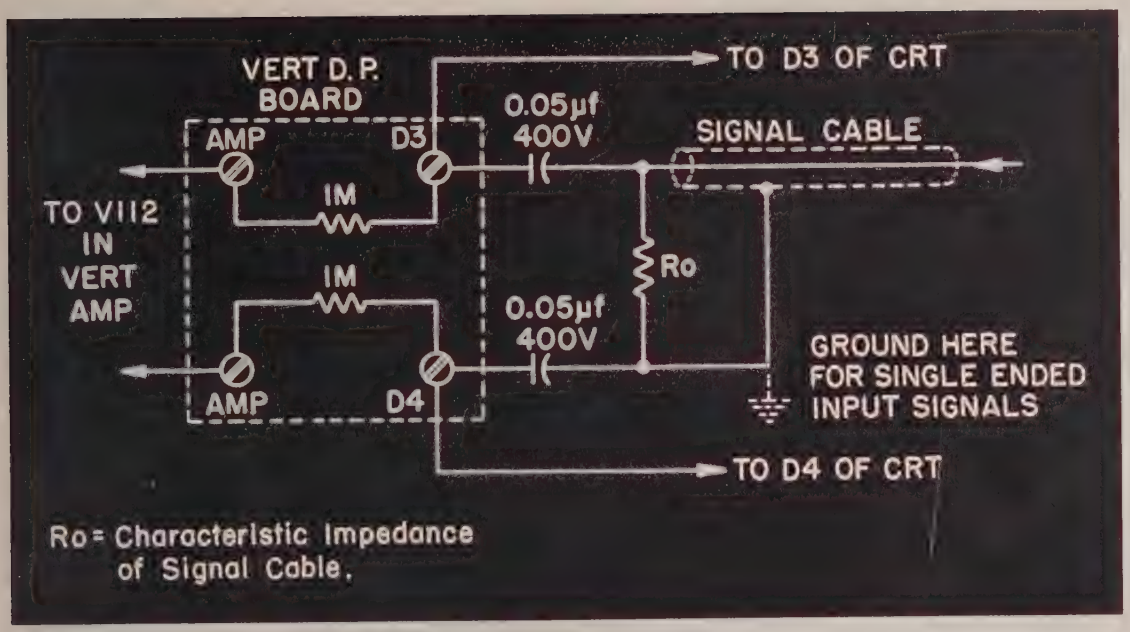


FIGURE 2-1. CIRCUIT FOR COUPLING AC SIGNALS DIRECT TO VERTICAL DEFLECTION PLATES

(5) DIRECT CONNECTION TO VERTICAL DEFLECTION PLATES

Direct coupling to the vertical deflection plates may be accomplished conveniently at terminals located behind the access door on the left side of the cabinet. When connecting direct to the deflection plates, approximately 23 volts peak-to-peak will be required to produce one major scale division of deflection. Before making connections, shut off the power.

(a) AC COUPLING

Remove the jumpers which connect D3 to AMP and D4 to AMP, and replace them with large isolation resistors (1 megohm maximum). Connect the signal leads to D3 and D4 through blocking capacitors of at least 400 dc volts rating. See following circuit for details. When thus connected, vertical positioning by the Y POSITION control is still available. *Do not connect signals directly to the D3 and D4 terminals, which are operating at several hundred volts above chassis potential.*

Waveforms having fast rise times may induce ringing in the coupling network and deflection plate wires, and one should be alert to evidence of this condition. Usually, such waveforms are fed to the oscillograph through a cable, terminated in its characteristic impedance, as shown. If ringing on the observed pulse is evident, it may normally be reduced or eliminated in one of the following ways:

1. If the loss of positioning voltage can be tolerated, remove the line termination and place it directly at the deflection plate terminals of the cathode-ray tube.

2. If loss of positioning cannot be tolerated, insert small damping resistors (in the order of 100 ohms) in each deflection plate lead. This latter method will normally reduce ringing considerably by eliminating some of the high-frequency components of the signal.

(b) DC COUPLING

DC coupling to the deflection plates may be accomplished, but external voltages for positioning will be required. The procedure is as follows:

Remove the jumpers which connect D3 to AMP and D4 to AMP, so that the plates are completely disconnected from the vertical am-

plifier. It will be necessary to provide a dc return path to ground of one megohm maximum in each deflection plate circuit. Connect the signal to the terminals D3 and D4. It must be remembered that when using this method, the deflection plates will not necessarily be at the proper potential for least astigmatism. If the ASTIGMATISM control is now readjusted to correct the astigmatism, the deflection sensitivity of the cathode-ray tube will be affected and loss of sweep calibration may result. This should be checked by applying an external calibrating signal of accurately known frequency and calibrating in a manner essentially as described in paragraph 4d of this section. When returning to normal amplifier connection, check setting of ASTIGMATISM control and sweep calibration. (See Section IV, Maintenance, for adjustment procedures.)

f. INTENSITY MODULATION

Input for intensity modulation of the trace may be connected to the front-panel type BNC connector marked Z INPUT, which presents an impedance of 12,000 ohms and 70 μμf to the externally connected circuit. An adapter is provided for use when the input cable is not equipped with a type BNC connector. Positive signals decrease beam intensity; 15 volts peak should blank the beam with normal INTENSITY control setting. To connect to cathode-ray tube cathode for intensity modulation at a lower input capacity (25 μμf), shut off the power, and remove the clear plastic cover from the top of the cabinet. Then move the jumper to connect the center pin and the pin marked DIRECT. Now, connect the intensity modulation signal between the jumper and GND.

5. Making Rise Time Measurements

By means of the calibrated sweep, pulse rise-time measurements may be obtained directly from the illuminated cathode-ray tube scale. When making such measurements, the one factor which must be borne in mind for most accurate quantitative results is the pulse response characteristic of the vertical amplifier. This characteristic is related to the observed pulse rise time and the actual pulse rise time in the following manner:

$$t_{ro} = \sqrt{t_{ra}^2 + t_{rp}^2}$$

Where t_{ro} is the observed rise time; t_{ra} is the minimum rise time of the amplifier; t_{rp} is the signal rise time.

The typical pulse response photograph found in Table 1-1 demonstrates the effect of the amplifier characteristic on the observed pulse; and from this photograph the amplifier rise time may be calculated, using the formula. Values taken from the photo are:

$t_{ro} = 0.04$ μsec

$t_{rp} = 0.02$ μsec

$t_{ra} = \sqrt{t_{ro}^2 - t_{rp}^2}$

$\sqrt{(4\text{x}10^{-2}\ \mu\text{sec})^2 - (2\text{x}10^{-2}\ \mu\text{sec})^2}$

$t_{ra} = \sqrt{(16-4)\text{x}10^{-4}}\ \mu\text{sec} = 2\sqrt{3\text{x}10^{-2}}\ \mu\text{sec}$

$t_{ra} \approx 0.035$ μsec

Once the amplifier rise time is known, the rise time of any pulse may be calculated. For most accurate results, the photograph should be enlarged before measurements are attempted.

Since deflection-plate misalignment is virtually eliminated through the use of tight-tolerance cathode-ray tubes, which allow a maximum of 1° of misalignment, no correction for this factor should be necessary.

When operating in the DRIVEN sweep mode, the amount of baseline visible ahead of the pulse presentation on screen is dependent upon the shape and rate of rise of the triggering signal. If the rise is fast, the sweep will be initiated and under way well within the 0.2 μsec delay period provided by the delay line in the vertical amplifier. But if the triggering signal rise is slow, such that the time required for it to reach the amplitude necessary to trigger the sweep plus the time required for the brightening gate to rise is 0.2 μsec or longer, the baseline will be lost along with some of the leading edge of the pulse.

Maximum baseline may be achieved by following these suggestions:

a. Use EXTernal sync whenever possible. When using INTernal sync, the signal is always attenuated by the Vertical Attenuator (except in the 0.2 step) before application to the sync amplifier. This attenuation is eliminated by employing EXTernal sync operation. The consequently larger signal will reach the necessary sweep triggering level in a shorter period of time, thus increasing observed baseline.

b. Set the MODE ADJ control fully CW.

c. Set the SYNCHRONIZATION (AMPLITUDE) control at maximum.

d. If INTernal sync is used, disconnect all

signals from the EXT SYNC terminal to prevent possible cross-coupling.

e. If the trigger pulse has a longer duration than the sweep, sweep distortion may occur when using the recommended maximum settings of the MODE ADJ and "sync amplitude" control. This condition may be avoided by employing the SYNC SHAPER switch on the front panel. When thrown to the IN position, the sync signal is applied through the differentiating network.

6. Photographic Recording

Permanent photographic records of oscillograms, with or without the super-position of the illuminated scale, are readily obtainable; and since the scale illumination level is adjustable from the front panel, the oscillogram and scale can generally be photographed simultaneously.

For detailed information on photographic recording of waveforms, the operator is referred to a booklet titled "Techniques of Photo-recording from Cathode-ray Tubes," published by the Instrument Division of Allen B. Du Mont Laboratories, Inc.

section 3
circuit theory

1. General

An over-all block diagram of the Du Mont Types 329 and 323 is shown in Section I, from which a complete general picture of incorporated circuitry may be obtained. Only somewhat unfamiliar or unusual circuitry will be described in detail, and to follow the discussion, the over-all schematic should be consulted as well as simplified schematics in this section.

2. Sync Circuit

The sync pick-off cathode follower (V102-A) serves two functions: (1) It couples the undelayed Y-input signal to the internal sync amplifier; and (2) isolates the internal sync amplifier from the Y-input cathode follower (V101), thus eliminating capacitive loading of the delay line. The output from the internal sync amplifier (V201-A) is coupled to the sync phase splitter (V201-B) when the "sync selector" switch (S201) is set at INT. This switch (S201) selects the synchronizing or triggering signal, either INternal (signal obtained from the internal sync amplifier); LINE-frequency (obtained from tube heater circuit); or EXTernal SYNC (signal obtained from an external source either straight through or with ten-to-one attenuation). The "sync amplitude" control (R215) provides continuously variable adjustment of amplitude and selection of sync voltage polarity obtained to the sync interstage amplifiers (V202-A, V203-A).

On DRIVEN and RECURRENT sweep modes of operation, an interstage amplifier circuit is employed which consists of two essentially conventional video amplifier stages (V202-A) and V203-A) with shunt peaking. Somewhat unconventional, however, is the circuitry in the cathode of V203-A. In the RECUR position of S301, the negative pulse output of V203-A synchronizes the gate generator through CR302. The bias on V203-A is adjusted by the LOCK-OUT ADJ control, R234, for proper d-c voltage at its plate to bias CR302 against sporadic triggering of the gate generator. In practice, it is adjusted for most stable sweep operation. In the DRIVEN position of S301, CR201 clips the triggering signal at a level determined by the setting of the MODE ADJ control, R310-A, which determines the bias on CR201.

Improved RECURrent HIGH-FREQuency synchronization results from the use of a cathode follower (V203-B) driving stage for the gate generator. When RECUR HI-FREQ is employed, gain is exchanged for bandwidth by eliminating the amplifying stages V202-A and V203-A and switching to a cathode follower V203-B. In this case, some sync signal is a-c coupled through C304. The crystal and the capacitor form a storage or counting-type circuit to divide down the sync frequency.

3. Gate Circuits

a. SWEEP GATE GENERATOR

1. GENERAL

A functional block diagram of the sweep-gate circuit is shown in Figure 3-1; the simplified schematic in Figure 3-2. To facilitate circuit analysis, part of the SWEEP MULTIPLIER-B switch (S302) is shown considerably simplified and with only one "gate feedback and holdoff" capacitor connected.

2. CIRCUIT DISCUSSION

When the SWEEP MODE selector switch is set at RECUR or RECUR HI-FREQ the SWEEP MODE control (R310-B) establishes proper bias on V301-B to make the multivibrator

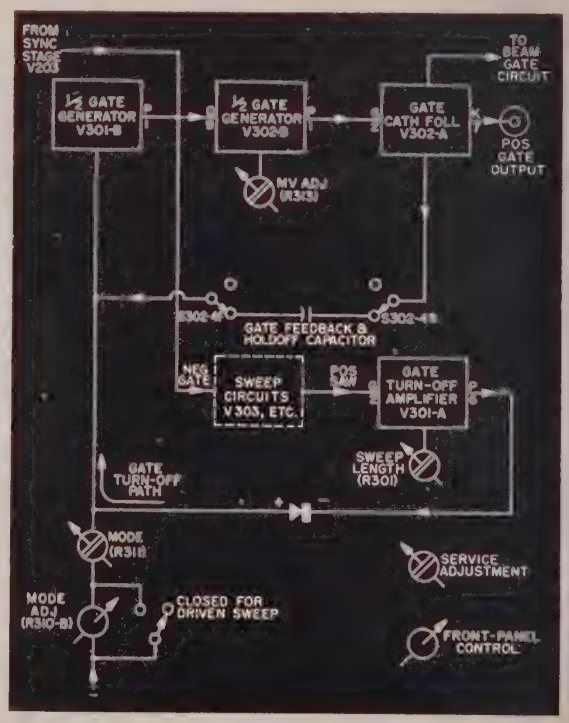


FIGURE 3-1.
GATE CIRCUIT, FUNCTIONAL BLOCK DIAGRAM

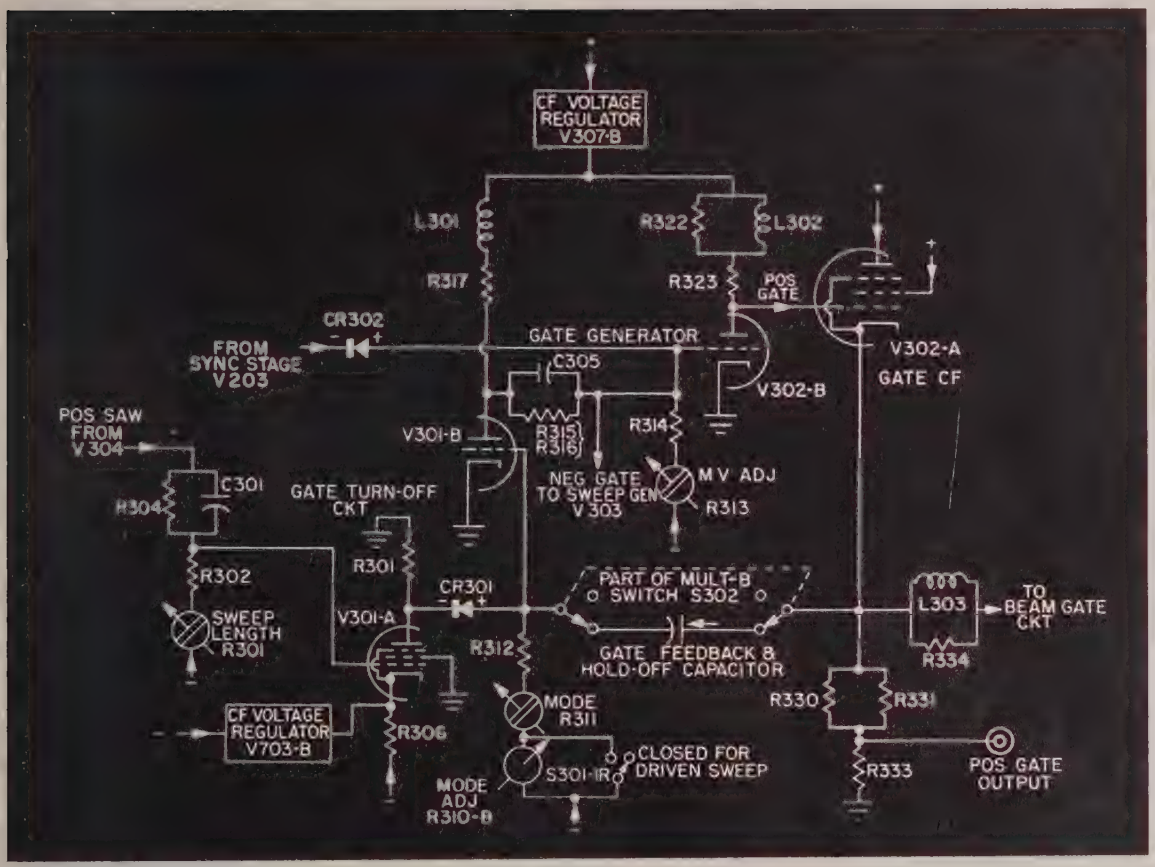


FIGURE 3-2. GATE CIRCUIT, SIMPLIFIED SCHEMATIC

gate generator free running. The repetition rate is determined by the time constant of the "gate feedback" capacitor selected, together with the resistance of R312, R311 and R310-B in series. When in the DRIVEN position, R310-B is shorted out, thus biasing V301-B beyond cut-off and making the circuit bi-stable with V302-B initially conducting. Synchronization or initiation of the circuit is accomplished by the application of a negative signal to the grid of V302-B. The negative gate output from this circuit is coupled to the sweep generator (V303), to "turn off" this tube and allow charging of the sweep capacitor.

A portion of the positive saw developed in the sweep circuit is coupled through a frequency-compensated voltage divider (R304 and C301, R302, R301) to the grid of the gate turn-off amplifier (V301-A). V301-A is biased beyond cut-off and will conduct when the forward portion of the sawtooth waveform reaches a certain amplitude as determined by the setting of R301. The resulting negative pulse at the plate is applied to the conducting tube (V301-B) of the gate generator to terminate the gate. The typical squarewave type multivibrator output gates the sweep generator (V303).

To avoid erratic triggering of the driven sweep during the recovery time of the sweep circuits, a gate "hold-off" circuit rejects all unwanted initiating triggers during this period. This is a differentiating circuit composed of

R312 in series with R311, together with the "hold-off" capacitor selected by S302. When the gate is terminated, the resulting negative signal at the cathode of V302-A is coupled to the grid of 301-B, holding it beyond cutoff. The time constant of the "hold-off" network determines how long it will be before a triggering impulse can again initiate the gate.

b. BEAM GATE CIRCUIT

The beam-gate circuit (see Figure 3-3) shapes the output from the gate generator and establishes it at the proper d-c level for application to the grid of the cathode-ray tube. Its operation assures a beam brightening signal of uniform amplitude for the duration of the sweep, even at low frequencies where the sweep-gate signal becomes differentiated by the circuit constants employed.

The heart of the circuit is the Beam Gate Generator, V401, a flip-flop circuit operating on voltages provided by the isolated power supply, V403. V401-B, the normally-off half, is turned on by the large gate signal applied to its grid, which in turn causes V401-A to be cut-off. Grid current in V401-B limits the swing of the signal to +40 volts and assures a flat top gate. When the gate signal once again swings negative the stage is flopped back to its original condition, and the negative excursion is held at 40 volts through the action of the limiter, V402-A. The result is a 40 volt positive gate of constant applitude which is applied directly to the Cathode-ray Tube for beam brightening.

4. Sweep Circuit

The over-all block diagram for the sweep circuit is shown in Figure 3-4, the simplified schematic in Figure 3-5.

The negative gate output from V301-B is coupled to the grid of sweep generator V303 (Figure 3-5), which is normally conducting and maintaining the sweep charging capacitor in a discharged state. The negative gate "turns off" V303 and allows the sweep capacitor (selected by the SWEEP MULTIPLIER-B switch) to charge through a series of charging resistors. The SWEEP MULTIPLIER-A control (R361) provides vernier adjustment of sweep writing rate by varying the charging voltage.

The resultant sawtooth voltage across the charging capacitor is coupled to the sweep cascode output circuit (V304 and V305). V304 is a cathode follower with V305 acting as its cathode load (saw assist tube). The signal appearing at the plate of V304 is coupled through C331 to the grid of V305 to facilitate charging of the

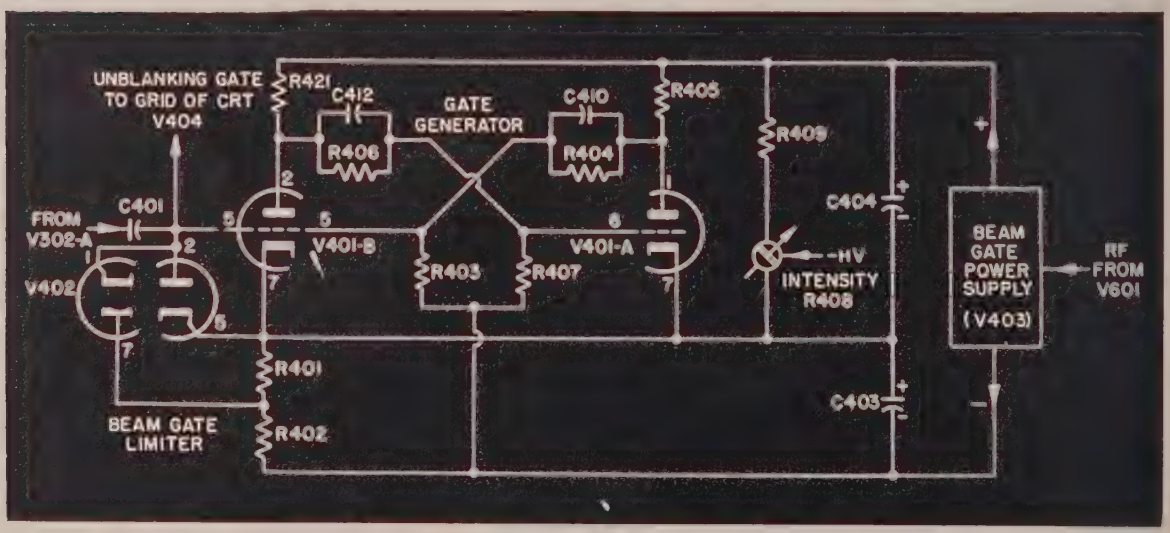


FIGURE 3-3. BEAM GATE CIRCUIT, SIMPLIFIED SCHEMATIC

"strays" at higher frequencies. A high degree of linearity is achieved by causing the d-c level of the charging surface to rise at saw rate through use of the saw regulator (V306-B, V307-A and V308). This essentially provides a constant-current charging source for the sweep capacitor. The saw regulator is also used to raise the d-c level of the positive saw applied to deflection plate D2.

To obtain a push-pull sweep signal for application to the deflection plates of the cathode-ray tube, an inverter stage (V309) is employed. Output from the cathode of V304 is directly coupled to one horizontal deflection plate (D2) through a d-c level-establishing circuit (Saw Regulator). Simultaneously, output of same polarity is applied from the junction of the frequency-compensated voltage divider (R373, C340, R376) to the grid of the inverter. This stage has approximately unity gain as a consequence of feedback from plate to grid; resulting in negligible over-all distortion. The resulting sawtooth waveform at the plate of the inverter is opposite in phase but of the same amplitude as that obtained from the cathode of V304 and is coupled to the other horizontal deflection plate (D1).

The sweep (either driven or recurrent) is terminated when the sawtooth output from the cathode of V304, applied to the grid of the gate turn-off amplifier V301-A (Figure 3-2) shuts off the gate.

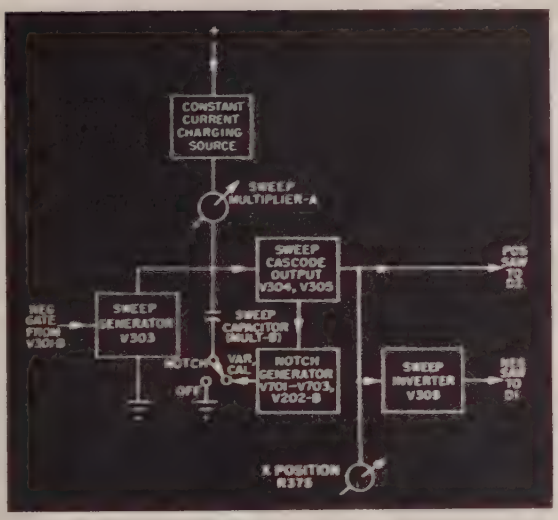


FIGURE 3-4.
SWEEP CIRCUIT, SIMPLIFIED BLOCK DIAGRAM

5. Sweep Notch

The notch circuit is shown in somewhat simplified form in Figure 3-6.

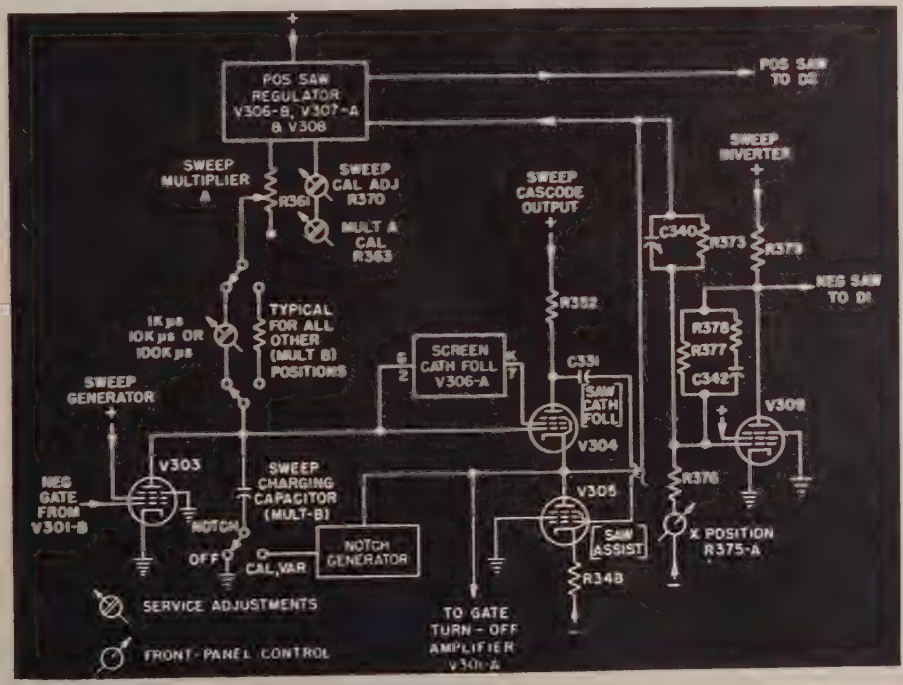


Figure 3-5. Simplified schematic of the sweep circuit used in the Du Mont Types 329 and 323 Cathode-Ray Oscilloscopes.

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circuit theory

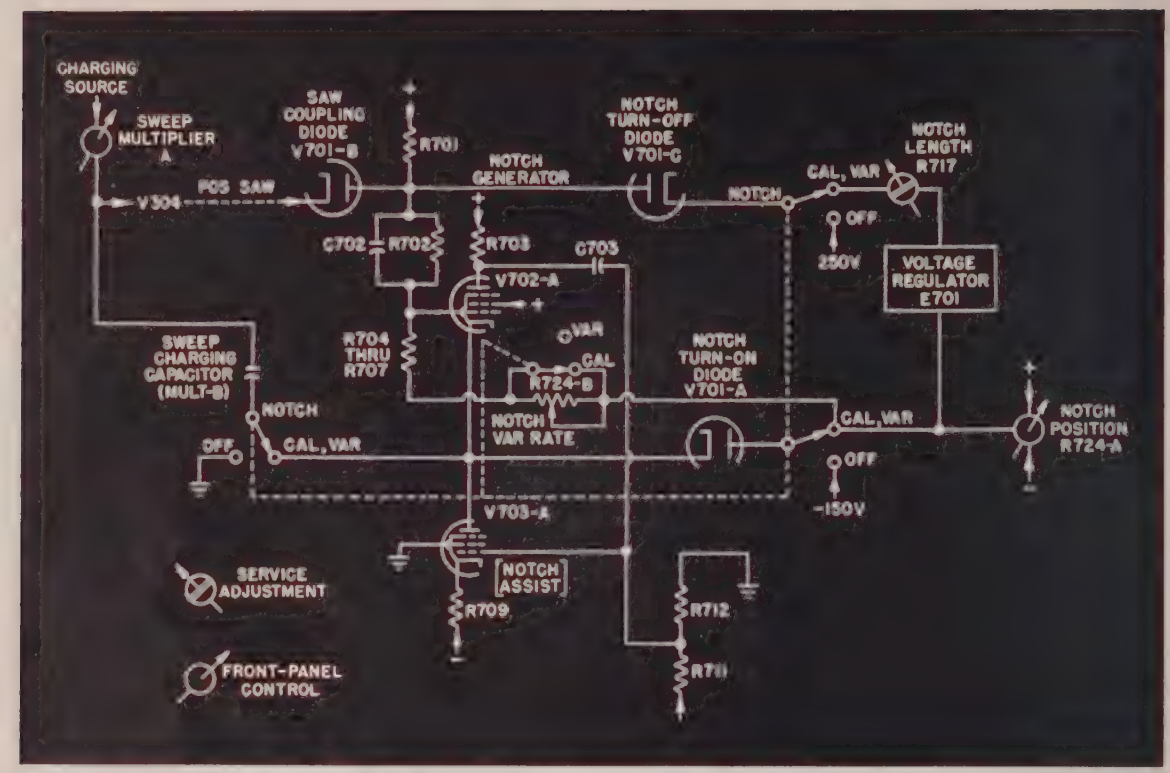


FIGURE 3-6. NOTCH CIRCUIT, SIMPLIFIED SCHEMATIC

The fundamental idea behind this circuit is to increase the apparent sweep capacitor charging rate during a selected portion of the sweep. The notch generator (V702-A and V703-A) is employed for this purpose and is connected in a cascode-type circuit.

When the NOTCH switch is in the OFF position, the sweep capacitor will charge in the normal manner. When the NOTCH switch is at VAR or CAL, the lower side of the sweep capacitor is connected to the cathode of V702-A. How long after the start of the sweep the notch commences, is determined by the bias on V702-A which is non-conducting before the beginning of the notch. The bias is established by the operator using the NOTCH POSITION control which sets the voltage at the plate of the "notch turn-on diode" (V701-A). V701-A is conducting until the start of the notch.

V703-A is always conducting, but V702-A is non-conducting until the saw on its grid reaches an amplitude sufficient to overcome the cutoff bias which corresponds to the start of the notch. When it conducts, its cathode follows, shutting off V701-A and bootstrapping the lower side of the sweep capacitor at slightly less than saw rate. The bootstrapping rate is fixed when the CAL notch is being used. When the VARiable rate notch position is employed, the bootstrapping rate is made variable through the use of the VARIABLE RATE control. Note that the action is cumulative in a regenerative manner. The over-all effect is a much greater apparent charging rate for the sweep capacitor, increasing the sweep speed on screen.

The action of the "notch turn-off diode" (V701-C) is such as to limit the length of the notch to a predetermined value. When the notch saw reaches an amplitude such that the plate of V701-C is at a higher potential than its cathode, it conducts; and, by limiting the voltage to V702-A, limits the saw voltage applied to the lower side of the sweep capacitor. The sweep then continues at pre-notch rate until terminated in normal manner by the gate. The notch is kept approximately uniform in length regardless of position on the sweep since a relatively constant voltage difference between plate of V701-A and cathode of V701-C is maintained

with a gas-tube regulator. Notch length is established by setting this constant difference potential with the NOTCH LENGTH service adjustment.

6. Voltage Calibrator

A functional schematic of the voltage calibrator circuit is shown in Figure 3-7. Since the power-line-frequency voltage which operated the calibrator comes from the high-voltage winding of T502 used to supply a voltage doubler, it is floated above ground at a fixed d-c voltage.

The a-c from T502 is applied to V508 through limiting resistor R538. With the pin 1 cathode tied to ground, any positive voltage impressed on this section of V508 will cause conduction, thus clamping the positive half cycle at approximately ground potential. On the negative half cycle, the voltage conduction occurs in the other section of V508 when the peak applied voltage exceeds —150 volts, thus clipping the wave at that point. The resulting clipped sine-wave voltage (150 volts peak-to-peak) is applied to one divider network (R 544 and R 545 on overall schematic) from which 0.2 volts peak-to-peak is obtained for application to the Y-input stage, and to another divider (R542 and R543) from which 0.4 volts peak-to-peak is fed to a front-panel jack (J501).

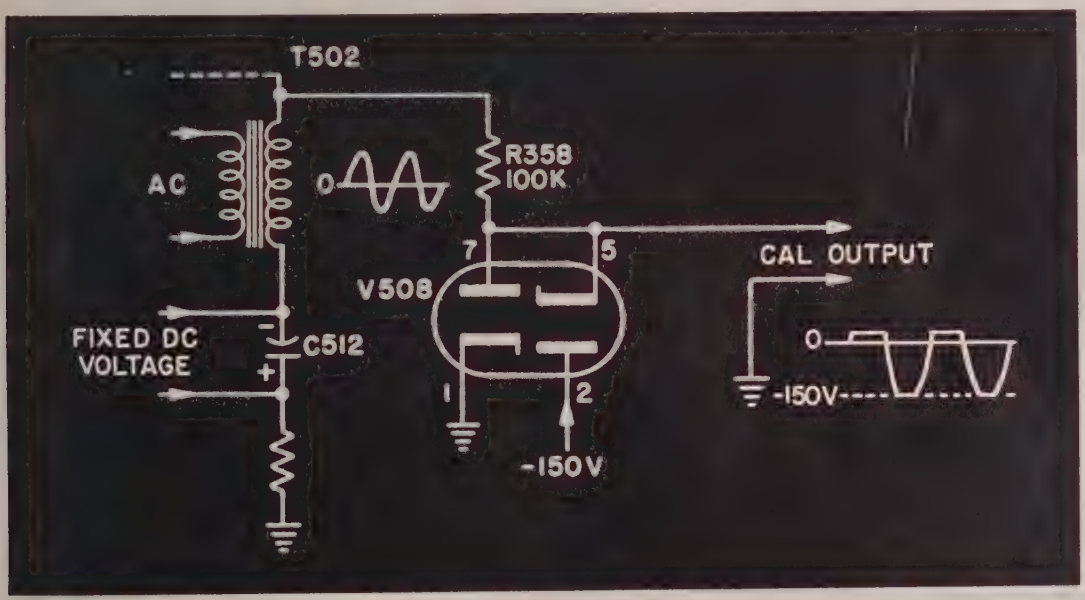


FIGURE 3-7. VOLTAGE CALIBRATOR, FUNCTIONAL SCHEMATIC

section 4
maintenance

1. General

Removal of the three screws at the rear of the cabinet allows the chassis to be withdrawn for maintenance.

— Warning —

POTENTIALS AS HIGH AS 6000 VOLTS ARE EMPLOYED IN THE TYPE 329 AND 2500 VOLTS IN THE TYPE 323. OBSERVE THE FOLLOWING PRECAUTIONS WHEN NECESSARY TO ENERGIZE THE EQUIPMENT WITH THE CABINET REMOVED.

(1) Never work alone.

(2) Make sure the chassis is properly grounded.

(3) Turn off power before changing any tubes.

(4) Before touching any component, short the terminals to remove any possible charge that may remain after turning off the power.

The first step in correcting any trouble or failure that may occur is to isolate the section of the circuit causing the trouble. Such isolation can be accomplished by considering the circuit as composed of the basic sections shown in the over-all block diagram, Figure 1-2, and by carefully comparing the symptoms to the functions of each block.

The next step after isolating the trouble to a particular section is to determine the specific tube circuit involved. A replacement tube should be tried before attempting any other tests. *Indiscriminate tube changing must be avoided. If after tube replacement, the trouble persists, replace the original tube in its socket.* NOTE: *Replacement of certain tubes will require resetting of one or more service adjustments. Consult Table 4-3 for special instructions.* If trouble persists, voltage and resistance measurements should be made, and waveforms should be observed using a separate oscillograph at critical points in the circuit.

2. Maintenance Reference Data

a. OVER-ALL SCHEMATICS

Over-all schematics of the circuits will be found at the back of this section and should be consulted while trouble shooting. A list of the component electrical parts, including descriptions, is also provided.

b. TROUBLE SHOOTING CHART

As an aid in servicing, Trouble Shooting Chart, Table 4-1, indicates symptoms, probable causes of trouble and remedies.

c. WAVEFORM DATA

Checking with a cathode-ray oscillograph for the presence of the correct waveform at critical points in the circuit often aids in the diagnosis of component or circuit failure. Figure 4-3 shows waveforms that should be observed at certain points in the circuit. Each is identified by a code letter which also appears on the schematic diagram to show the exact point at which it occurs. In addition, the voltage levels are given in each illustration. The front-panel control settings employed were:

Y INPUT SELECTOR	CAL (A thru H) or AC 1 (II thru DD) to provide full scale deflection
Y CAL ADJ (Y GAIN)	
SWEEP MODE	DRIVEN
MODE ADJ	to provide stable sweep
SYNCHRONIZATION (SELECTOR)	INT
(AMPLITUDE)	+50
SWEEP MULTIPLIER-A, SWEEP MULTIPLIER-B	to obtain several cycles or intervals on screen
SYNC SHAPER	OUT

Waveforms Y to DD — illustrate the "notch" operation, and were obtained by throwing the NOTCH switch to CAL and setting the NOTCH position control to have the "notch" in the center of the screen.

d. VOLTAGE AND RESISTANCE MEASUREMENTS

Table 4-2 lists voltages and resistances from tube pins to ground except as otherwise noted.

Voltage measurements shown were taken using a test meter having an internal resistance of 20K ohms/volt except as otherwise noted. Good judgment is often required to determine if a particular deviation from the value shown is indicative of trouble.

3. 230-Volt Operation

To change from 115-volt to 230-volt line operation, first turn off the power. Set the 115/230-volt selector switch (Figure 4-10) to 230V. Change the fuse from 5A slow blow to 3.2A slow blow. The 3.2A fuse is included in an envelope along with the set-screw wrench for the MULTIPLIER-A dial.

4. Tube Locations

Tubes may be located by reference to call-out photographs, Figures 4-4 through 4-10.

5. Service Adjustments

a. GENERAL

Service adjustments may be identified by reference to the call-out photographs, Figures 4-4 through 4-10. Do not touch any service adjustment unless tests clearly indicate necessity therefore. These adjustments rarely drift and require resetting only upon tube replacement. Such adjustments should not be attempted without complete understanding of the proper procedure.

Before making any adjustments, a 15-minute warm-up period must be allowed.

Caution

TO AVOID SCREEN BURNS, KEEP INTENSITY LOW.

Certain service adjustments, listed in Table 4-3, may need to be reset when replacing tubes.

b. TEST EQUIPMENT REQUIRED

Description	*Range of Characteristics*
Time Calibrator	Pulse repetition rate: 100 cps, 1 kc, 10 kc, 100 kc, and 1 mc; 3 volts peak. Sine-wave output: 10 mc, 2 volts peak. Accuracy: ±1%
Sine-wave Generator	2 megacycles to 20 megacycles 1 volt peak
Square-wave Generator	2500 cycles to one megacycle
Volt-ohmmeter	20K ohms/volt Test Meter or Vacuum Tube Voltmeter

Precaution

DO NOT SET ANY SERVICE ADJUSTMENTS WITHOUT FOLLOWING SPECIFIC INSTRUCTIONS GIVEN BELOW. MANY CONTROLS ARE INTERDEPENDENT.

c. POWER SUPPLY CIRCUITS

(1) —150 ADJ (R530) — Check d-c voltage at any point on chassis marked "—150." Adjust to —150 volts by means of R530 (Figure 4-8). Be sure to use a meter which is accurate to ±0.5 volt at 150V.

(2) Checking Balance of the Type 6080 Tubes (V502 and V504) — If the Type 6080 tubes are changed, the new tubes should be checked for balance between halves by measuring the voltage drop across the 47 ohm plate load resistors. Replace resistors if they show signs of having been subjected to excessive heat. If there is an unbalance of greater than 20% proceed as follows: If the resistor at Plate, Pin 2, has the greater voltage drop, disconnect the lead on the Cathode, Pin 3, and connect it to the other Cathode, Pin 6. Conversely, if the resistor at the Plate, Pin 5, has the greater voltage drop, move the cathode lead from Pin 6 to Pin 3.

d. CATHODE-RAY TUBE CIRCUITS

(1) ASTIGMATISM (R413 — see Figure 4-4) —Check by applying the CALibrator pattern or a 60-cycle sine wave signal to Y INPUT. Adjust the sync, mode, sweep and positioning controls to obtain several cycles on the screen. Adjust the FOCUS control for the sharpest trace, which should now be of uniform width throughout its length. If not, adjust the ASTIGMATISM control to obtain this condition. It will probably be necessary to readjust the FOCUS control simultaneously with the ASTIGMATISM potentiometer to maintain best focus. Once properly adjusted, the ASTIGMATISM control should require no further attention under normal conditions.

(2) CRT Screen Voltage Adjustment (Type 329 only) — With the CALibrator signal applied and DRIVEN sweep employed, advance the INTENSITY control CW and see if the trace remains bright at maximum intensity and zero sync. If it does, the CRT cut-off voltage should be checked. The voltage across R401 should

be between 36 and 46 volts with the INTENSITY control fully CCW; if not, the voltage must be readjusted.

Turn off the instrument and interchange R415 and R416. Connect a voltmeter between grid and cathode of CRT; turn on the instrument and measure voltage at which CALibration trace extinguishes. This should fall between 45 and 55 volts. CAUTION: THE VOLTMETER WILL BE AT —6KV WITH RESPECT TO GROUND. OBSERVE SAFETY PRECAUTIONS.

(3) FOCUS Control Bleeder — R417 to R420 — (Type 329 only)—When the Cathode-ray Tube is changed, the voltage range of the FOCUS control may have to be adjusted to maintain focus at low and normal intensity. This is done by shorting out any two resistors of the bleeder with the jumpers provided. *Two* of the resistors *must* always be shorted.

e. SYNC AND SWEEP CIRCUITS

(1) MODE (R311 — see Figure 4-9) — For normal operation of the driven sweep, set SWEEP MODE at DRIVEN, "sync amplitude" fully CW, "sync selector" at INT, MODE ADJ fully CCW, and Y INPUT SELECTOR at CAL. MODE (R311) is set at the point where the sweep just fails to trigger.

(2) LOCKOUT ADJ (R234 — see Figure 4-8) — Set SWEEP MODE at DRIVEN, "sync amplitude" at zero and MODE ADJ fully clockwise. Check by placing a d-c voltmeter from V203 pin 1 to ground. The reading should be 0.4 volt. If not, adjust R234 to bring reading to 0.4 volt.

(3) Recurrent High-frequency Sync Adjustment —When V203 is changed it may be necessary to move the resistor tap (jumper) located in its pin 7 grid circuit in order to obtain high frequency sync operation. To check, set SWEEP MODE at RECUR HI-FREQ, "sync selector" at INTernal, SWEEP MULTIPLIER-A at 1, SWEEP MULTIPLIER-B at 0.1, and obtain full-scale deflection of a 20 mc sine wave signal applied to Y INPUT. If the sweep collapses to the right, select another position for the tap (see schematic for locations) such that the sweep does not collapse. A very sharp pattern should be seen when EXTernal sync is employed.

(4) MV ADJ (R313 — see Figure 4-9) — After the LOCKOUT ADJ is set or is determined to be correct, place a VTVM from the junction of R314 and R315 to ground. A reading of 6.2 volts should be obtained. If not, adjust R313 accordingly. For this adjustment use DRIVEN sweep with no sync input.

(5) LENGTH (R301 and C301 — see Figure 4-9)—Set SWEEP MODE to RECUR, SWEEP MULTIPLIER-A at 1, and SWEEP MULTIPLIER-B at 1K. Sweep length of at least 4 major scale divisions should result. If not, adjust R301 accordingly. Next, set SWEEP MULTIPLIER-B at 1.0. If sweep is short, adjust the trimmer capacitor, C301, to re-establish a sweep length of at least 4 major scale divisions. Sweep calibration is not effected by length, therefore sweep may be set slightly longer than 4 divisions if necessary.

Caution:
Before starting, turn the INTENSITY control fully CCW to avoid screen burns.

(6) Sweep Inverter Compensation Capacitor (C340 — see Figure 4-9) — Disconnect the red lead which couples the unblanking gate to the P.W. Gate Board at the pin marked GATE INPUT. Apply the POS GATE OUTPUT signal to Y INPUT and set SWEEP MULTIPLIER-B at 100, MULTIPLIER-A at 1, "sync selector" at EXT, SWEEP MODE at RECUR, and MODE ADJ at the threshold of recurrent sweep. Using a non-metallic screwdriver, adjust C340 to eliminate the tail at the lower left hand corner of the pattern. Replace the GATE INPUT connection.

During the adjustment sufficient brightness should be available to see both the forward and return sweep trace. If not, turn on the brightening gate by momentarily reconnecting the lead to GATE INPUT.

(7) SWEEP CAL ADJ (R370 — see Figure 4-8) —To check setting of R370, proceed as follows: Set SWEEP MULTIPLIER-B at 100, SWEEP MULTIPLIER-A at 1, Y INPUT SELECTOR at A-C or D-C, SWEEP MODE at DRIVEN, "sync amplitude" at maximum, and "sync selector" at INT. Apply a 10-kc pulse to Y INPUT and set the MODE ADJ and positioning controls for a stable pattern centered on the screen. Note whether a four-interval pulse pattern (five pulses) appears in four major divisions; if not, adjust R370 until such a pattern is obtained.

(8) MULT-A CAL (R363—see Figure 4-9)—Before checking, make sure that the SWEEP CAL ADJ is properly set as explained in the preceding paragraph (7), To check the necessity of adjusting R363, proceed as follows: Employ the same front-panel control settings as in paragraph 7, except for SWEEP MULTIPLIER-A which should be set at 10. Apply a 1-kc pulse to Y INPUT. A four-interval pulse pattern should appear in four major divisions; if not, adjust R363 until such a pattern is obtained.

(9) SWEEP MULTIPLIER-A dial setting—Set MULTIPLIER-B on reference range (100). THE MULTIPLIER-A dial is then adjusted on its shaft so that the "jump-off" point of the pot coincides with the reference mark to the left of the 1 end of the dial. This is done by bringing a 100 KC pulse into the notch at the clockwise end of MULTIPLIER-A dial. The jump-off is the point at which the pulses in the notch start to move as MULTIPLIER-A dial is turned counter-clockwise. Then set SWEEP CAL ADJ (R370) and MULT-A CAL (R363) as described previously. Check linearity of sweep after setting R363 by observing whether the middle pulse is within 0.15 minor divisions of the center.

Apply a 10kc pulse to the Y INPUT and by means of MULTIPLIER-A dial produce a 12 interval (13 pulses) pattern in 4 major divisions and observe reading of MULTIPLIER-A dial. It shall be between 2.97 and 3.03. If the reading is too far off, the deviation from 3 should be scaled with a divider and the "jump-off" line near 1 be moved over by this distance; clockwise for clockwise deviation and counter-clockwise for counter-clockwise deviation. A light pencil mark may be made to locate the new "jump-off" point. The "jump-off" point should never move to the right of 1.

The dial is then reset for the new "jump-off". The 1 end is readjusted. The MULT-A CAL is then reset. Again the 3 position is checked. The dial will need to be slipped again if the reading does not fall between the two limits, 2.97 to 3.03. The dial screw should be very well tightened after its alignment is correct. A set-screw wrench is included in the 230V fuse envelope for this purpose. The knob tightening shall be checked by turning the small friction drive knob until the dial comes to the end. Further turning of the friction drive shall cause the drive to slip. The dial however shall under no condition slip on the shaft of the potentiometer. If the dial cannot be tightened sufficiently to prevent slippage, the reducing bushing in the knob is probably improperly aligned; remove dial, align slot in bushing with slot in knob, and reassemble the dial. It will, of course, be necessary to reset the dial completely.

(10) 0.1 usec (C320—see Figure 4-9)—Before checking, make sure that the SWEEP CAL ADJ and the MULT-A CAL are checked out as given in the preceeding paragraphs: (7) and (8).

To check the necessity of adjusting C320, proceed as follows: Set SWEEP MULTIPLIER-A at 5, SWEEP MULTIPLIER-B at 0.1, SWEEP MODE at DRIVEN, and apply a 1 megacycle pulse signal to Y INPUT. A two-cycle pattern should appear in four major divisions; if not, adjust C320 until such a pattern is obtained.

(11) 1 us (C328—see Figure 4-9)—Before checking, make sure that the SWEEP CAL ADJ and MULT-A CAL are checked out as given in paragraphs (7) and (8).

To check the necessity of adjusting C328, proceed as follows: Set SWEEP MULTIPLIER-A at 1, SWEEP MULTIPLIER-B at 1.0, SWEEP MODE at DRIVEN, and apply a one-megacycle pulse to Y INPUT. A four-interval pulse pattern should appear in four major divisions; if not, adjust C328 until such a pattern is obtained.

(a) 1 us N. ADJ (C329—see Figure 4-9)—The 1 us N. ADJ (C329) is set in conjunction with C328. To adjust, set SWEEP MULTIPLIER-A dial to make 5 pulses occur between 1 and 2 on the calibrated scale (five minor divisions). Turn the NOTCH switch to CAL and set the NOTCH POSITION control to stretch the pattern between 0.5 and 1.5 on the calibrated scale. Next, employ the X POSITION control to bring the nearest pulse to 1 on the scale. Set the 1 us N. ADJ (C329) to space the two pulses within the notch to exactly 1 major scale division apart. Turn the NOTCH switch OFF and count the number of pulses between 1 and 2. If the count is not exactly 5, C328 must be readjusted. Switch the NOTCH to CAL and observe whether the two pulses in the notch are still one major division apart; readjust C329 if necessary. After the 1 us N. ADJustment has been completed, set the SWEEP MULTIPLIER-A dial back to 1; check the 1 us sweep adjustment (C328) and readjust if necessary.

(12) 10 usec (C326—see Figure 4-9)—Before checking, make sure that the SWEEP CAL ADJ and MULT-A CAL are checked out as given in paragraphs (7) and (8).

To check the necessity of adjusting C326, proceed as follows: Set SWEEP MULTIPLIER-A at 1, SWEEP MULTIPLIER-B at 10, SWEEP MODE at DRIVEN, and apply a 100-kilocycle pulse to Y INPUT. Note whether a four-interval pulse pattern appears in four major divisions; if not, adjust C326 until such a pattern is obtained.

(13) 1K usec (R339—see Figure 4-9)—Before checking, make sure that the SWEEP CAL ADJ and MULT-A CAL are checked out as given in paragraphs (7) and (8).

To check the necessity of adjusting R339, proceed as follows: Set SWEEP MULTIPLIER-A at 1, SWEEP MULTIPLIER-B at 1K, and apply a one-kilocycle pulse to Y INPUT. Note whether a four-interval pulse patters appears in four major divisions; if not, adjust R339 until such a pattern is obtained.

(14) 10K usec (R338—see Figure 4-9)—Before checking, make sure that the SWEEP CAL ADJ and MULT-A CAL are checked out as given in paragraphs (7) and (8).

To check the necessity of adjusting R338, proceed as follows: Set Y INPUT SELECTOR at CAL, SWEEP MODE at DRIVEN, SWEEP MULTIPLIER-A at 2.5 (60-cycle line only), and SWEEP MULTIPLIER-B at 10K. Note whether a six-cycle pattern appears in four major divisions; if not, adjust R338 until such a pattern is obtained.

(15) 100K usec (R337—see Figure 4-9)—Before checking, make sure that the SWEEP CAL ADJ and MULT-A CAL are checked out as given in paragraphs (7) and (8).

To check the necessity of adjusting R337, proceed as follows: Set Y INPUT SELECTOR at CAL, SWEEP MODE at DRIVEN, SWEEP MULTIPLIER-A at 1 (60-cycle line only), and SWEEP MULTIPLIER-B at 100K. Note whether a 24-cycle pattern appears in four major divisions; if not, adjust R337 until such a pattern is obtained.

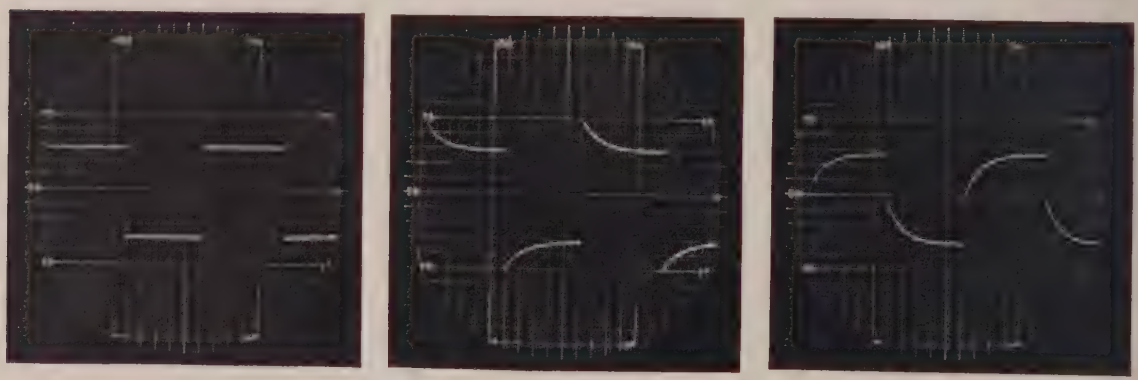
f. SERVICE ADJUSTMENTS FOR THE NOTCH CIRCUIT

(1) NOTCH LENGTH ADJ (R717—see Figure 4-9)—The length of the notch should be two major divisions, if it is not, proceed as follows: Set SWEEP MODE to RECUR, SWEEP MULTIPLIER-B at 1K, Y INPUT SELECTOR at A-C or D-C with no signal input, and NOTCH switch on CAL. Advance the MODE ADJ control to get a trace. Set NOTCH POSITION to start the notch at the end of the first calibrated major scale division. Adjust R717 to make the end of the notch fall on the end of the third major scale division.

g. SERVICE ADJUSTMENT FOR THE Y AMPLIFIER

(1) Y POS BAL and Y D-C BAL (R132 and R128)—These are front-panel screwdriver controls which, when properly set, prevent vertical shifting of the trace with adjustment of the Y CAL ADJ (GAIN) control. For adjustment procedure, see Section 2, Operation, paragraph 4e (2).

(2) HUM BUCKING ADJ (R184—see Figure 4-9)—To check the necessity of adjusting R184, proceed as follows: set VOLTS FULL SCALE at 400, Y INPUT SELECTOR at CAL, SWEEP MULTIPLIER-A at 10, SWEEP MULTIPLIER-B at 10K, Y CAL ADJ fully counter-



(A) Correct Waveform

(B) Over Compensated

(C) Under Compensated

FIGURE 4-1. WAVEFORMS ENCOUNTERED IN ADJUSTING VOLTS FULL SCALE SWITCH COMPENSATION CAPACITORS

clockwise, "sync selector" at LINE, SWEEP MODE at DRIVEN, and adjust MODE ADJ for a steady trace. Switch the Y INPUT SELECTOR off the CAL position and check for ripple on the trace; if noted, adjust R184 for minimum (0.02 inch max.).

(3) DE-GAS (R122—see Figure 4-6)—This control compensates for gas currents in the input stage, V101. To check and/or adjust, proceed as follows: Set Y CAL ADJ fully clockwise, VOLTS FULL SCALE at 0.2, Y INPUT SELECTOR at D-C, and ground the Y INPUT terminal. Position the trace to the vertical center by the Y POSITION control. Next, set the Y INPUT SELECTOR to A-C and reposition the trace to vertical center by the DE-GAS control. This adjustment will often have to be reset during the first 72 hours of operation following tube replacement (see Table 4-3) since the gas currents will change considerably in this period.

(4) VOLTS FULL SCALE Compensation Capacitors—See Figures 4-4 and 4-5 for location. Trimmer capacitors C107, C110, C113, C116, C119, C122, C125, C128 and C130 provide high frequency compensation for all steps of the VOLTS FULL SCALE attenuator switch except the 0.2 and 0.4 steps. They may be checked by applying a 2.5 kc square wave signal to Y INPUT and adjusting, the appropriate trimmer if necessary, to pass the square wave with minimum distortion. In Figure 4-1, "A" represents proper adjustment while "B" and "C" represent conditions of over and under-compensation, respectively.

(5) Output Stage Peaking Coil Alignment (L111 through L114)—These coils should not normally require readjustment except upon replacement. (See Figure 4-7 for location). Before attempting to adjust the peaking coils of the output stage, any distortions due to misalignment of the driver stage must be eliminated. This is accomplished by inserting a 150 ohm network in the driver stage to reduce its gain and increase its bandwidth. The circuit and its location is shown in Figure 4-2. A 4 μμf capacitor should also be added across the deflection plate board connections (D3 to D4).

Set VOLTS FULL SCALE at 0.2 and switch the delay-line leads for *direct* signal input. Apply a one megacycle square wave to Y INPUT and adjust the appropriate front-panel controls for a two-cycle pattern one major scale division in amplitude. Set L111 through L114 at minimum inductance (screws out at maximum). The series (L113 and L114) and shunt (L111 and L112) coils are then adjusted for an optimum square-wave pattern. When these adjustments are completed, the corresponding shunt or series coils should have their screws protruding the same distance. Remove the resistor network and

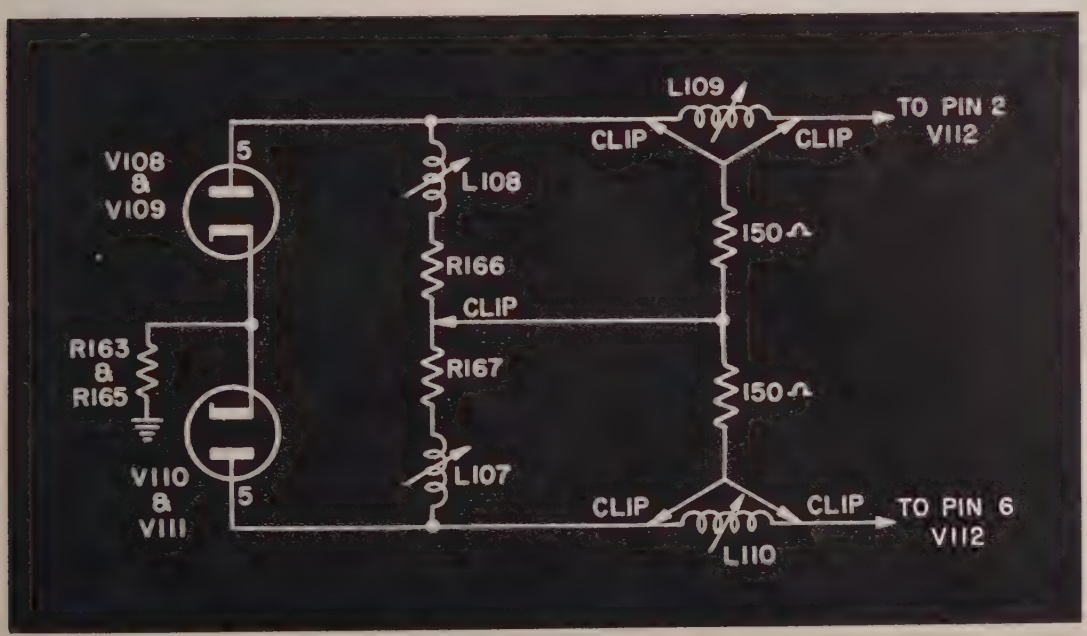


FIGURE 4-2. PEAKING COIL ADJUSTMENT NETWORK

the 4 μμf capacitor at the conclusion of the test. Switch the delay line back in.

(6) Driver Stage Peaking Coil Alignment (L107 through L110)—These coils should not normally require readjustment except upon replacement. (See Figure 4-7 for location.) The series (L109 and L110) and shunt (L107 and L108) peaking coils are aligned in a manner similar to that outlined in the preceding paragraph except that the network shown in Figure 4-2 and the 4 μμf capacitor are not employed. Be sure that the delay line is out of the circuit for this adjustment and is switched back in at the conclusion of the test.

(7) Delay Line Adjustments—These adjustments have been carefully set by the manufacturer and should not normally require readjustment. To test, note the effect of a one megacycle square-wave signal applied to Y INPUT with the delay line out of the circuit, then inserted. The signal should be identical in either case. If not, readjustment is probably necessary. If so, proceed as follows: First make sure that the delay line is connected in the circuit. With a 100KC square-wave signal applied to the Y INPUT, adjust the sync and sweep controls for a two-cycle pattern. Starting at the output end of the delay line (C847) and working towards the input end (C801) adjust the individual trimmers for optimum square wave response (smoothing out the individual wiggles). Then apply a one-megacycle square-wave signal and repeat the above procedure.

(8) D-C COMP ADJ (R156—see Figure 4-9) —To check for d-c compensation in the vertical amplifier, note the effect of a D-C voltage connected to the Y INPUT on a one-second/division DRIVEN sweep. The spot should sweep across the screen in a horizontal line. If not, R156 probably requires readjustment. Before adjusting R156, check for CRT misalignment or bowing of the sweep by observing a high frequency sweep.

To adjust, set SWEEP MODE to DRIVEN, Y INPUT SELECTOR to D-C, SWEEP MULTIPLIER-A at 10, SWEEP MULTIPLIER-B at 100K and adjust positioning and other appropriate controls to position the spot to the lower left side of the screen. Set D-C COMP ADJ fully clockwise. Apply a d-c voltage to Y INPUT and adjust VOLTS FULL SCALE and Y CAL ADJ to obtain a deflection of two major scale divisions. NOTE: The d-c voltage must be applied intermittently to Y INPUT to initiate each cycle of the driven sweep. Observe the progress of the spot and adjust R156 until it sweeps across the screen in a straight horizontal line.

6. Replacement of Cathode-Ray Tube

Caution

The cathode-ray tube should be handled with great care to prevent breakage, which might result in serious personal injury from flying glass. Do not employ force at any time. As an added precaution, it is advisable to wear safety goggles and gloves.

The following procedure is suggested for replacing the cathode-ray tube.

Step 1. Turn off power and remove chassis from cabinet.

Step 2. Remove bezel, scale, and filter held by four screws at front panel.

Step 3. Disconnect the five caps from the tube neck contacts and note their respective positions.

Step 4. Remove tube through front-panel opening. To do so, insert thumb into center of base socket and push.

Step 5. When installing the new tube, push it in far enough so that it is completely engaged in socket.

Step 6. Connect the five caps to the appropriate neck contacts (see schematic, if necessary).

Step 7. Loosen the clamp-adjusting bracket holding the tube assembly.

Step 8. Replace filter, scale, and bezel.

Step 9. Move tube assembly forward until the face of the tube just touches the filter; tighten bracket.

Step 10. Apply power and check the sweep; if not horizontal, loosen socket clamp and rotate tube as required. Tighten socket clamp, being careful not to rotate tube in so doing. CAUTION: High voltage is present on the gate board; use an insulated screwdriver.

Step 11. Before replacing instrument in cabinet, refer to Table 4-3 to determine the necessary service adjustments required when replacing the cathode-ray tube.

7. Illuminated Scale Lamp Replacement

Defective scale lamps are removed as follows:

Step 1. Turn off power and withdraw chassis from cabinet.

Step 2. Remove the appropriate lamp assembly located on the rear side of the front panel by depressing the spring clip. The defective bulb may then be removed and replaced.

8. Lubrication

Both bearings of the fan motor should be lubricated with a few drops of light machine oil once a month or after 500 hours of use.

9. Du Mont "Oscillographer"

The Du Mont "Oscillographer," a periodical, is published by the Allen B. Du Mont Laboratories, Inc., and is sent free of charge to engineers, research workers, and those engaged in the use and application of cathode-ray equipment. When sending in subscriptions or when sending notification of change of address, please supply the following information: name, company name, company address, type of business, and title of individual.

10. Du Mont Warranty

All instruments produced by the Instrument Division of Allen B. Du Mont Laboratories, Inc., are sold under the Du Mont Warranty. For the provisions of this warranty, see the Warranty and Service Notice on the inside cover.

11. Service

The Instrument Division maintains complete facilities for servicing DuMont equipment. For details of the Instrument Service policies, see the Warranty and Service Notice on the inside back cover.

TABLE 4-1
TROUBLE SHOOTING CHART

POWER SUPPLY AND CRT CIRCUITRY

SYMPTOM	PROBABLE CAUSE	REMEDY
Pilot indicator fails to light	Line cord not plugged into a live outlet	Trace line failure
	Pilot indicator lamp open	Replace I501
	Blown fuse	Replace F501. For 115V operation use 5A slow-blow fuse; for 230V operation use a 3.2A slow-blow fuse
	115/230 voltage selector switch (S502) defective	Make certain the 115/230 voltage selector switch is set at the proper voltage. Check continuity of switch with POWER at "off"
		CAUTION: If this switch is replaced, it must be wired in accordance with the power supply schematic drawing to insure the proper phase relationship of the primaries on transformer T501
	Defective POWER ON switch (S501)	Replace
Line fuse blows when POWER switch is turned ON	Incorrect fuse type or rating	Check F501; should be slow-blow type and have 5A rating for 115V operation or 3.2A rating for 230V operation.
Line fuse blows when POWER switch is turned on (con't.)	Defective power supply	1. Make resistance checks of +420V and +250 V supplies as follows:

TABLE 4-1 TROUBLE SHOOTING CHART (Continued)

POWER SUPPLY AND CRT CIRCUITRY

SYMPTOM	PROBABLE CAUSE	REMEDY
		<table><tr><th>Point of Measurement</th><th>Resistance to Ground</th></tr><tr><td>Pin 2 or 5 of V502</td><td>43K</td></tr><tr><td>Pin 2 or 5 of V504</td><td>27K</td></tr><tr><td colspan="2">Negative side of meter connected to gnd for above readings</td></tr></table> 2. Resistance between prongs of the line cord a. POWER switch off; infinity b. POWER switch ON; 0.5 ohm (115V*) 1.0 ohm (230V*) *Voltage Selector Switch
No spot on cathode-ray tube screen. SWEEP MODE selector at DRIVEN Y INPUT SELECTOR at D-C and no sync signal input	INTENSITY control turned down	Advance INTENSITY control until dim spot appears.
	Spot might be depositioned, due to a defective vertical amplifier stage	1. To check, short together the plates of V112. If spot returns to center, one or more vertical amplifier stages are defective. 2. Refer to "Vertical Deflection Circuitry (Y-axis)" of this Table to localize the trouble.
	Defective high-voltage delay relay (K101) (Type: 329 only)	This relay delays the application of high voltage to the CRT until the screens of V108 through V111 draw current. 1. Check that the relay armature operates. 2. If armature operates, but high voltage is not applied to the CRT, the relay contacts are dirty or oxidized and should be cleaned.
No spot on cathode-ray tube screen. SWEEP MODE selector at DRIVEN Y INPUT SELECTOR at D-C and no sync signal input (con't.)	Defective negative high-voltage regulated supply	Check the output of the high-volt supply (FOCUS pot is convenient point) 1. Type 323: voltage should measure between —2200 and —2350 volts. 2. Type 329: voltage should measure between —5660 and —5890 volts. 3. If improper voltage is indicated, measure voltage at Pin 8 of V501. See Table 4-2 for proper value. If much too low, trouble is in regulator system (see item 4 which follows). If voltage on V501 is normal, the oscillator tube, V601, the rectifier, V602, or the trans-

TABLE 4-1 TROUBLE SHOOTING CHART (Continued)

POWER SUPPLY AND CRT CIRCUITRY		
SYMPTOM	**PROBABLE CAUSE**	**REMEDY**
		former, T601, may be defective. Trouble may also be a shorted H.V. filter capacitor. 4. Also check the voltage and resistance of the h-v regulator amplifiers (V501-B, V503-B, and V505-B) per V and R Table. Check R603 for proper value.
	Defective low-voltage regulated supplies	The low voltages are required for application to the plate and screen of the r-f oscillator (V601). These voltages are also required for the proper operation of the h-v regulator.
No spot on cathode-ray tube screen. SWEEP MODE selector switch at DRIVEN, Y INPUT SELECTOR at D-C, and no sync signal input (con't.)		Check the output of the +420, +250, and —150-volt regulated supplies as outlined in the "Symptom" column.
	Defective cathode-ray tube	Check across heater-supply voltage at T502, terminals 14 and 15, which should measure 6.3 VAC. This measurement may be made on the gate board. USE EXTREME CAUTION!! Negative high voltage exist across these terminals to ground.
Can't position spot in the vertical plane	One or more tubes of the d-c heater series circuit is defective (V101 thru V107, V201 and V203)	Check continuity of the d-c heater series circuit as per power supply schematic to determine if defect is an open heater. If heaters are OK, then check tubes for other defects.
	Defective d-c level circuit (V102-B)	Check for a slight d-c voltage swing (5.2V to 5.4V) at the grid (pin 1) of V104 while varying the Y POSITION control.
Spot shifts position with variations in line voltage	Defective 6485 in vertical amplifier (V108 thru V111)	Replace tubes one at a time, replacing original in socket if found not to be defective. A new tube may cause this effect until it is sufficiently aged.
	Defective regulated supplies (—150V, +420V, and +250V)	1. There should be no change in the regulated output of the —150-volt, +420-volt, or +250-volt supply. Poor regulation is usually accompanied by incorrect voltage output of these supplies, and is nearly always caused by bad series regulator or control amplifier tubes.
Spot shifts position with variations in line voltage (con't.)		a. Tube replacement should be tried first. b. Check the voltage and resistance of the respective supplies. 2. —150-volt circuitry: Check tube pin voltage and resistance of the shunt regulator (V507),

TABLE 4-1 TROUBLE SHOOTING CHART (Continued)

POWER SUPPLY AND CRT CIRCUITRY

SYMPTOM	PROBABLE CAUSE	REMEDY
		the regulator control amplifier (V505-A) and of the voltage VR reference level (V506). 3. +420-volt circuitry: Check tube pin voltage and resistance of the series regulator (V502) and of the regulator control amplifier (V501-A). 4. +250-volt circuitry: Check tube pin voltage and resistance of the series regulator (V504) and of the regulator control amplifier (V503-A).
Spot size varies as it is positioned over the screen (non-uniform focus)	ASTIGMATISM control (R413) improperly set	Refer to "Service Adjustments for the Cathode-ray Tube" in this Section.
Uniformity of trace brightness varies with INTENSITY settings	Stray pick-up at Z INPUT terminal (idle connector or cable is coupled to terminals)	Short out Z INPUT
	Also, r-f on trace will give this effect (intensity markers)	1. Replace filter capacitors C601, (C602-Type 323 only), C603 and/or C604. Filter capacitors may be open; check by shunting another capacitor across the suspected one before replacing.
	Loose r-f shield or cover on the r-f supply	Check and tighten if necessary.
No calibration pattern. Y INPUT SELECTOR at CAL	Defective vertical amplifier	See "Vertical Deflection Circuitry." Symptom. No trace on screen, to track down this trouble.
	Y INPUT SELECTOR defective	Repair or replace.
	Amplitude calibrator (V508) may be defective	Check and replace.

GATE AND SWEEP CIRCUITRY

No sweep; SWEEP MODE set at RECUR	Gate stability adjustment (MV ADJ R313) and/or driven sweep mode adjustment (MODE R311) improperly set	Refer to the paragraph entitled "Service Adjustments for the Sweep Circuit" in this Section for the proper checking procedure.
	Defective SWEEP MODE selector switch	Repair or replace.
	Deflection-plate caps disconnected from neck contacts	Check that the deflection-plate caps (D1 and D2) are firmly connected to the neck contacts on the cathode-ray tube.
	The gate and/or sweep circuits are defective	To quickly localize the trouble, note whether the spot is resting on the right or left side of the screen, and proceed as follows:

TABLE 4-1 TROUBLE SHOOTING CHART (Continued)

GATE AND SWEEP CIRCUITRY		
SYMPTOM	**PROBABLE CAUSE**	**REMEDY**
No sweep; SWEEP MODE set at RECUR (con't.)		1. If spot is resting at the left, replace the gate generator tubes (V301 and V302). Try V302 first. 2. If spot is resting at the right, check for –60 volts at pin 7 (cathode) of the gate turn-off amplifier (V301-A). If –60 volts is not observed, replace the cathode-follower regulator (V703) for this stage. 3. If suggestions 1 and 2 fail to clear up the trouble, try the one-at-a-time method of replacing the following tubes. a. Sweep circuitry: V303, V304 and V305. b. Sweep regulated supply: V306, V307 and V308. NOTE: The original tube should be restored to its socket if not found to be defective. 4. A check of voltage and resistance may indicate other defective component (s) (stages V301 through V308). 5. Waveform Information: No waveform comparisons can be made if there is no sweep. However, a separate oscillograph may be employed to determine where sweep stops IF the gate generator is working.
Approximately 1/2 of sweep trace is missing. SWEEP MODE set at RECUR	Sweep inverter amplifier (V309) defective	1. Try replacement tube for V309. 2. Check with a separate oscillograph for the correct waveform at V309: pins 2 or 9 (grid) and pin 6 (plate). If improper waveform is noted, replace V309. 3. If suggestions 1 and 2 fail to clear up the trouble, check voltage and resistance of V309.
	Disconnected horizontal deflection plate lead	Check connections to CRT neck contacts and replace disconnected lead.
SYNC AND SWEEP CIRCUITRY		
No sweep; SWEEP MODE at DRIVEN; "sync selector" at LINE. Sweep ok at RECUR	INTENSITY control set too low	Advance INTENSITY control setting.

TABLE 4-1 TROUBLE SHOOTING CHART (Continued)

SYNC AND SWEEP CIRCUITRY

SYMPTOM	PROBABLE CAUSE	REMEDY
	Inadequate amplitude of sync initiation signal	Adjust "sync amplitude" control for the proper phase and amplitude of the synchronization signal.
	Defective sync circuitry (V201-B, V202-A and V203-A)	1. Check with a separate oscillograph for the proper waveform (see Figure 4-3) at the following points. a. Input to sync phase splitter V201-B; pin 7 (grid); ouput at either pin 6 (plate) or pin 8 (cathode). b. Input to 1st sync interstage amplifier V202-A: pin 2 (grid); output at pin 6 (plate). c. Input to 2nd sync interstage amplifier V203-A: pin 2 (grid), output at pin 1 (plate). 2. An improper waveform will indicate the defective sync stage or an open coupling capacitor (C209 through C212). 3. Tube replacement should be tried first. 4. A check of voltage and resistance may indicate other defective component (s).
No sweep; SWEEP MODE at DRIVEN; "sync selector" at LINE. Sweep ok at RECUR (con't.)	Sync sensitivity adjustment (LOCKOUT ADJ R234) improperly set	Refer to the paragraph entitled "Service Adjustments for the Sweep Circuit" in this Section for the proper checking procedure.
	Driven sweep mode adjustment (MODE, R311) improperly set	Refer to preceding comment.
No sweep; SWEEP MODE at DRIVEN, Y SELECTOR at CAL, "sync selector" at INT	SYNC SHAPER switch at IN position. CAL signal not passed to V203-A	Throw SYNC SHAPER switch to OUT.
Loss of synchronization; SWEEP MODE at RECUR	"Sync selector" switch not set to the proper position	Refer to Operating Instructions in Section 2.
	Defective SWEEP MODE selector switch, section S301-1F	Repair or replace.
	Sync coupling diode (CR302) defective	Check and replace.
	SYNC SHAPER switch at IN	Throw switch to OUT when using CAL or low-frequency signals.

TABLE 4-1 TROUBLE SHOOTING CHART (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
SYNC AND SWEEP CIRCUITRY		
Loss of synchronization SWEEP MODE at RECUR HI-FREQ	Frequency of synchronization signal too high or too low	Refer to Operating Instruction in Section 2.
		Replace V203. A check of voltage and resistance will indicate other defective components.
	Incorrect grid tap position (V203)	Check and reset top position as outlined in paragraph on Service Adjustments for Sync and Sweep Circuits in this section.
MISCELLANEOUS SWEEP CIRCUITRY		
Sweep less than four major scale divisions	Sweep length adjustments (LENGTH) R-301 and C301—improperly set	Refer to appropriate paragraph under "Service Adjustment for the Sweep Circuit" in this Section for the proper checking procedure.
	Gate turn-off grid divider resistors (R302 and R304) may have changed in value beyond the specified tolerance	Check and replace.
Non-linearity of sweep observed when a 100-kc pulse is applied to Y INPUT. SWEEP MULTIPLIER-A at 1 and -B at 10	Sweep inverter attenuator trimmer (C340) requires adjustment	Refer to appropriate paragraph under "Service Adjustments for the Sweep Circuit" in this section.
Non-linearity of sweep at lower frequencies. (An appropriate signal is applied to Y INPUT)	Gassy saw cathode follower (V304)	Check and replace. If new tube fails to correct trouble, replace old tube in socket.
SWEEP CALIBRATION		
1. A known frequency is applied to the Y amplifier. Sweep writing rate/division does not tally with SWEEP A x B dial setting (SWEEP MULTIPLIER-B at 100)	SWEEP CAL ADJ (R370) and/or MULT-A CAL (R363) improperly set	Refer to SWEEP CAL ADJ and/or MULT-A CAL paragraphs under "Service Adjustments for the Sweep Circuit" in this Section.
2. Same as "Symptom 1" except SWEEP MULTIPLIER-B is set at 0.1	0.1 μsec (C320) service adjustment improperly set	Refer to the appropriate heading under "Service Adjustments for the Sweep Circuit" in this Section for the proper checking procedure.

TABLE 4-1 TROUBLE SHOOTING CHART (Continued)

SYMPTOM	PROBABLE CAUSE	REMEDY
SWEEP CALIBRATION		
3. Same as "Symptom 1" except SWEEP MULTIPLIER-B is set at 1	1 μs (C328) service adjustment improperly set	Refer to preceding comment.
4. Same as "Symptom 1" except SWEEP MULTIPLIER-B is set at 10	10 μsec (C326) service adjustment improperly set	Refer to comment in this column, under "Symptom 2."
5. Same as "Symptom 1" except SWEEP MULTIPLIER-B is set at 1K	1K μsec (R339) service adjustment improperly set	Refer to comment in this column under "Symptom 2."
6. Same as "Symptom 1" except SWEEP MULTIPLIER-B is set at 10K	10K μsec (R338) service adjustment improperly set	Refer to comment in this column under "Symptom 2."
7. Same as "Symptom 1" except SWEEP MULTIPLIER-B is set at 100K	100K μsec (R337) service adjustment improperly set	Refer to comment in this column under "Symptom 2."
NOTCH CIRCUITRY		
No notch; sweep ok; NOTCH switch at CAL	Defective notch generator (V701-B, V702-A and V703-A)	1. Check for the proper waveforms at the following points: a. At input to saw coupling diode V701-B: pin 7 (cathode); output at pin 6 (plate). b. At input to notch cathode follower V702-A: pin 2 (grid); output at pin 7 (cathode) or at V703-A; pin 6 (plate of saw assist stage). 2. If improper waveforms are noted, check the Notch Turn-on Circuitry as outlined elsewhere in this Table.
No notch; sweep ok; NOTCH switch at CAL (con't.)	Defective notch Turn-on circuitry (V701-A and V202-B)	1. Check voltage at the following points while simultaneously advancing the NOTCH POSITION control. a. At notch turn-on cathode-follower regulator V202-B: pin 8 (cathode) which should measure from 0 to 50 volts. b. At notch turn-on diode V701-A: pin 2 (plate) voltage should agree with "a" above. c. If discrepancies exist between "a" and "b", check NOTCH switch, section S303-1R.

TABLE 4-1 TROUBLE SHOOTING CHART (Continued)

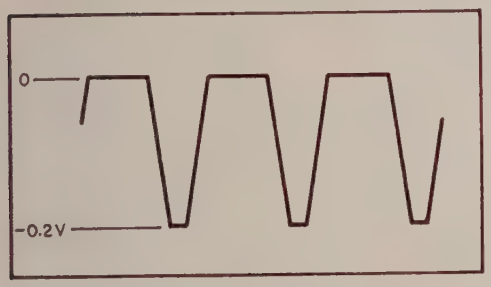
SYMPTOM	PROBABLE CAUSE	REMEDY
NOTCH CIRCUITRY		
		2. Tube replacement (s) should be tried first. 3. A further check of voltage and resistance of the notch generator and/or notch turn-on circuitry will reveal other defective component (s).
Incorrect notch length	NOTCH LENGTH ADJ (R717) improperly set	See "Service Adjustment for the Notch Circuit" in this Section.
	Defective notch turn-off circuitry (V701 and V702-B)	1. Check voltage at the following points while simultaneously advancing the NOTCH LENGTH (R717) service control from fully CW to fully CCW. a. At notch turn-off cathode-follower regulator V702-B pin 8 (cathode) which should measure from 45 to 90 volts. b. At notch turn-off diode V701-C pin 9 (cathode) voltage should agree with "a" above. c. If "a" and "b" do not agree, check NOTCH switch, section S303-1R. 2. Tube replacement should be tried first. 3. A further check of voltage and resistance will reveal other defective component (s).
VERTICAL DEFLECTION CIRCUITRY (Y-AXIS)		
No trace on screen. Y INPUT SELECTOR switch set to CAL	Trace may be depositioned off screen due to a defective vertical amplifier stage	To check, short together the plates of V112. If trace returns to center, one or more vertical amplifier stages are defective. Trouble shoot as outlined in the adjacent Probable Cause column.
	Defective negative high-voltage regulated supply	Refer to appropriate remedy column of this table under "Power Supply and CRT Circuitry" to localize the trouble.
	Defective low-voltage regulated supply	Refer to preceding comment.
	Low or no gain vertical amplifier stage	1. A check for the proper waveform at the following points will indicate the defective stage: a. Junction of R544 and R545. (This point indicates the output of the voltage calibrator). b. Input cathode follower V101: pin 3 or 8 (cathode). Continuity of Y INPUT SELECTOR. switch — CAL — checked.

TABLE 4-1 TROUBLE SHOOTING CHART (Continued)

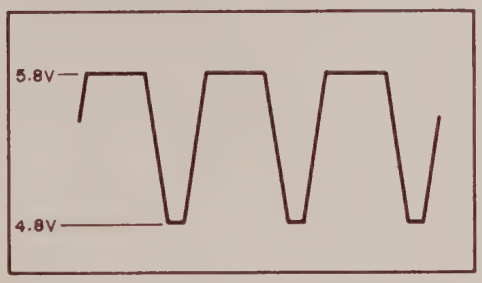
VERTICAL DEFLECTION CIRCUITRY (Y-AXIS)

SYMPTOM	PROBABLE CAUSE	REMEDY
No trace on screen. Y INPUT SELECTOR switch set to CAL (con't.)		c. Interstage cathode follower V103-B; pin 8 (cathode). d. Input to cathode-coupled phase splitter V105: pin 1 (grid); output at pin 5 (plate); and at V104: pin 5 (plate). e. Push-pull cathode follower V106-A: pin 3 (cathode); V106-B: pin 8 (cathode). f. Push-pull driver amplifier V108 and V109: pin 5 (plates); V110 and V111: pin 5 (plates). g. Final push-pull deflection amplifier V112: plate caps. 2. A check of tube pin voltage and resistance may reveal other defective component (s).
No vertical signal when Y INPUT SELECTOR switch is set at either A-C position; signal is present when switch is set at D-C	Defective SELECTOR switch S101-2F (C102 and C152 not connected)	Replace or repair.
Trace shifts (up and down) with changes in the setting of the Y CAL ADJ (Y GAIN) control	D-C balance adjustments (Y POS BAL and Y D-C BAL) improperly set	Refer to "Service Adjustments for the Y Amplifier" in this Section.
Power-line frequency ripple on trace	HUM BUCKING ADJ (R184) improperly set	Refer to preceding comment.
Intermittent or jumpy trace—with or without Y INPUT signal	Defective tube-to-socket contact or corrosion of tube pins	Check and clean.
	High resistant PW (printed wiring) connections to PW pins	Check by exerting gentle pressure on various parts of the PW board to pin point the intermittency when found, resolder pin (s) by hand.
	High resistant PW connections between components and PW pins	Refer to preceding comment.
	Broken resistor (s) or peaking coil (s) PW connections	Check for continuity while pressing or tapping component under suspicion.
	Damaged PW conductor	Replace damaged conductor with insulated wire following original path. Do not use a solder bridge.

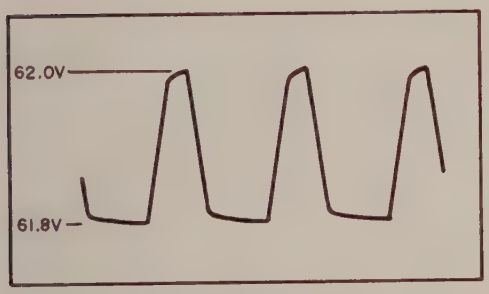
WAVEFORMS OF VERTICAL AMPLIFIER WITH CALIBRATOR SIGNAL APPLIED



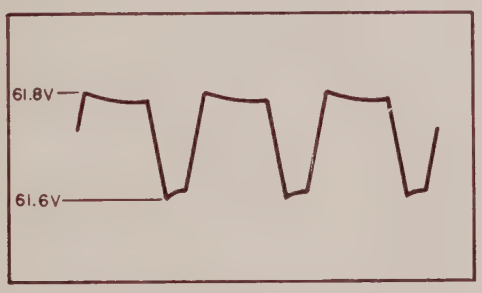
A. Junction R101 & R102



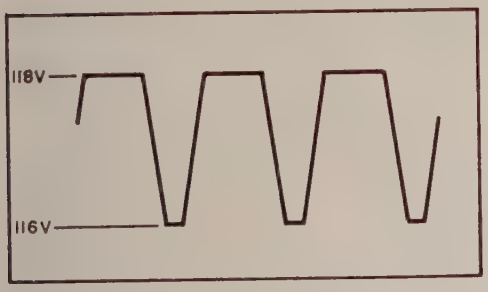
B. V103-B Cathode, Pin 8



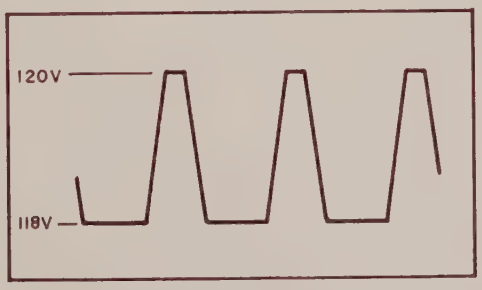
C. V105 Plate, Pin 5



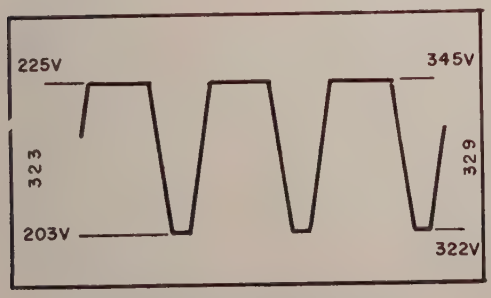
D. V104 Plate, Pin 5



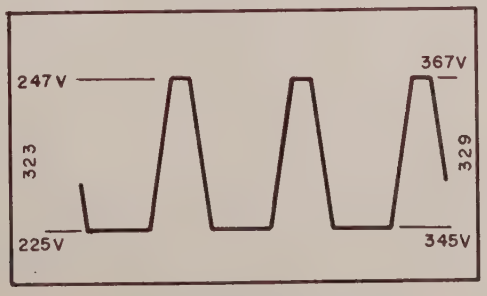
E. V110, V111 Plate, Pin 5



F. V108, V109 Plate, Pin 5



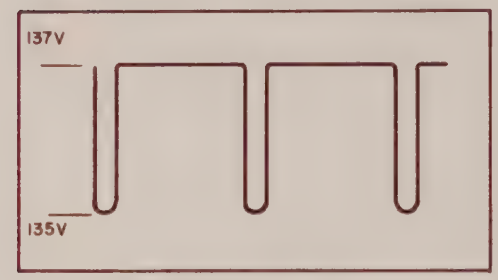
G. V112 Plate, Cap (D3)



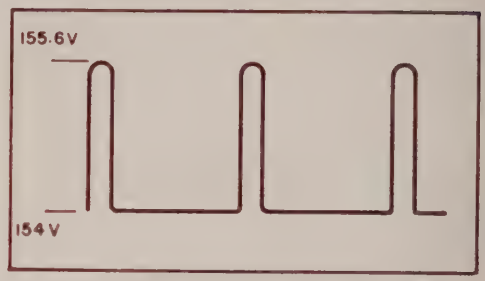
H. V112 Plate, Cap (D4)

FIGURE 4-3. TYPICAL WAVEFORMS

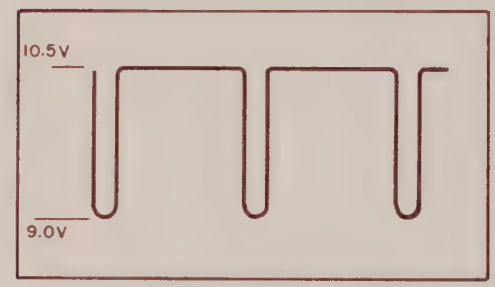
WAVEFORMS OF SYNC AND SWEEP CIRCUITS WITH POSITIVE PULSE OF 0.2V PEAK APPLIED TO Y INPUT; Y SELECTOR AT AC 1



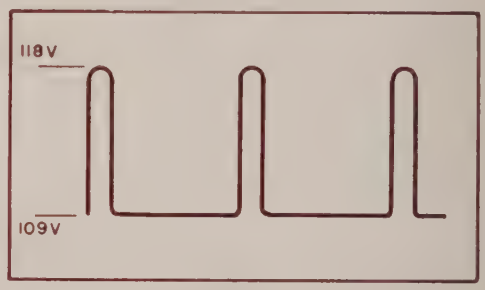
I. V201-A Plate, Pin 1



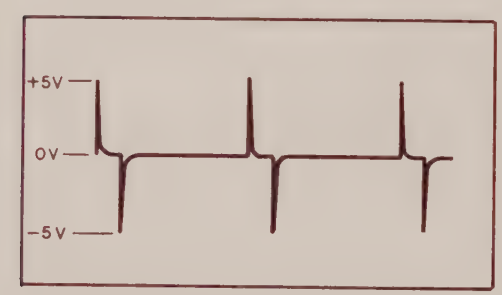
J. V201-B Plate, Pin 6



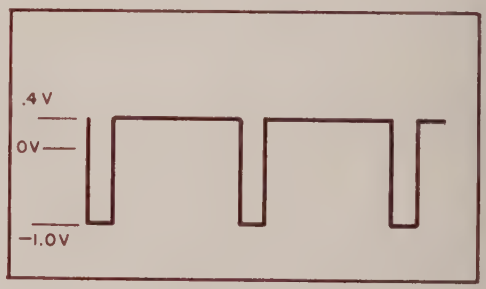
K. V201-B Cathode, Pin 8



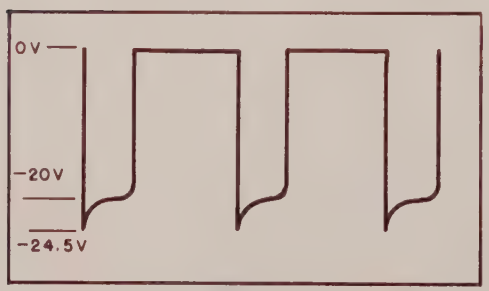
L. V202-A Plate, Pin 6



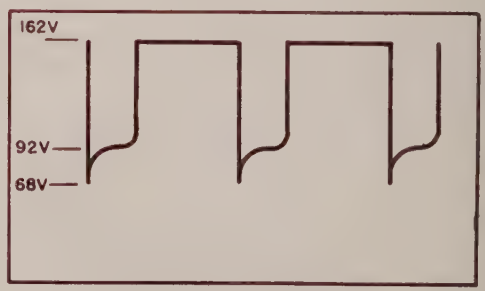
M. Junction C216 & C221
Sync Shaper At In



N. V203-A Plate, Pin 1



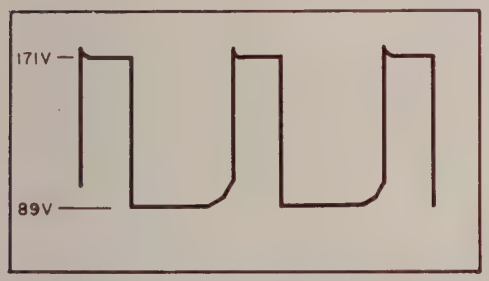
O. V302-B Grid, Pin 9



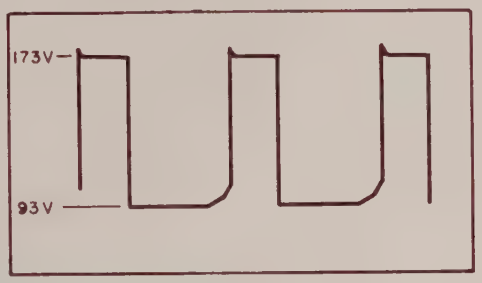
P. V301-B Plate, Pin 1

FIGURE 4-3. TYPICAL WAVEFORMS (con't.)

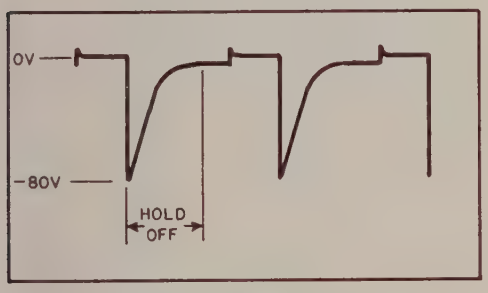
WAVEFORMS OF SYNC AND SWEEP CIRCUITS WITH POSITIVE PULSE OF 0.2V PEAK APPLIED TO Y INPUT; Y SELECTOR AT AC 1



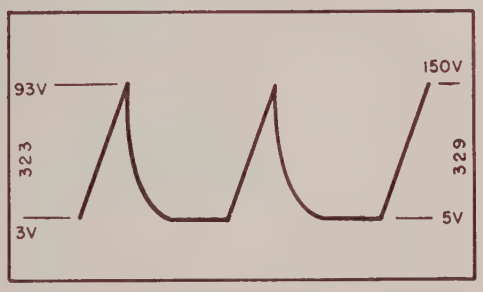
Q. V302-B Plate, Pin 1



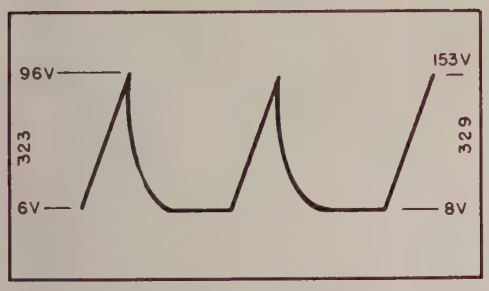
R. V302-A Cathode, Pin 7



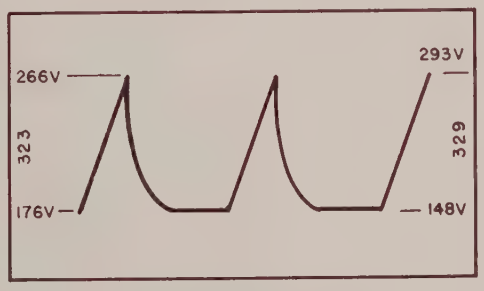
S. V301-B Grid, Pin 9



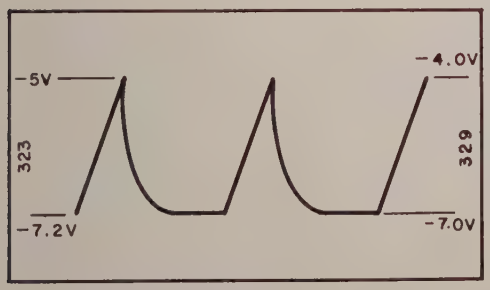
T. V304 Grid, Pin 2



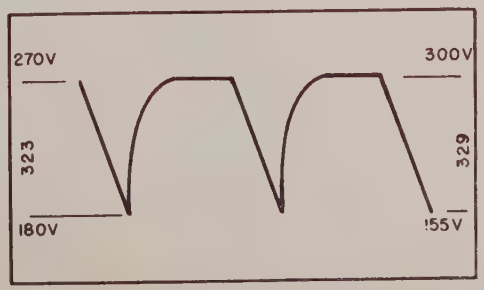
U. V304 Cathode, Pin 1



V. V306-B Cathode, Pin 8



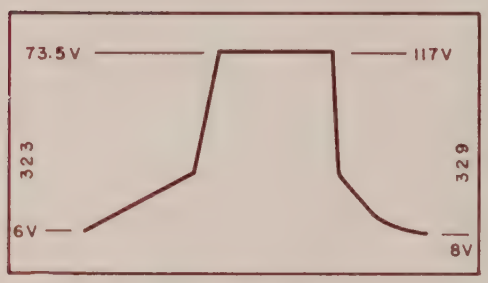
W. V309 Grid, Pins 2 & 9



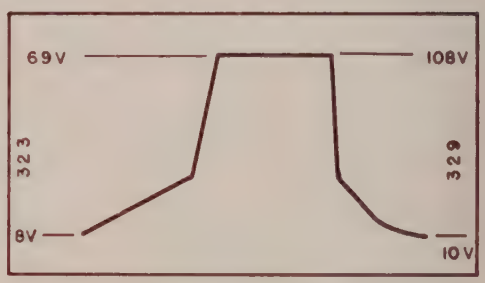
X. V309 Plate, Pin 6

FIGURE 4-3. TYPICAL WAVEFORMS (con't.)

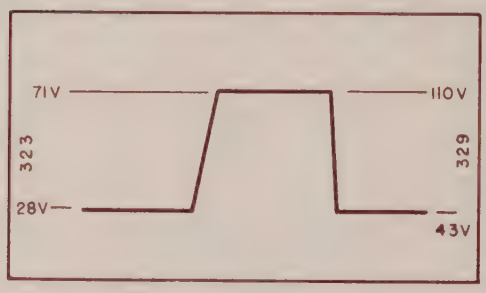
WAVEFORMS OF SWEEP AND NOTCH CIRCUITS WITH NOTCH OPERATING, NOTCH SWITCH IN CAL POSITION, SWEEP RATE APPROX 1/5 THAT OF !. THRU X.



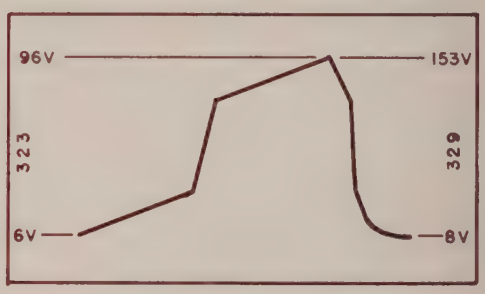
Y. V701-B Plate, Pin 6



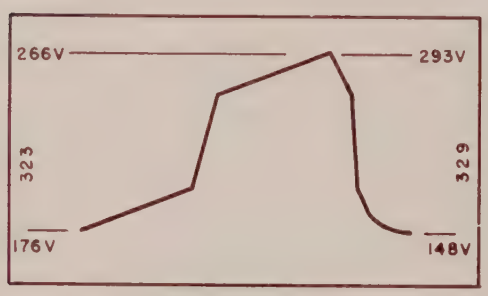
Z. V702-A Grid, Pin 2



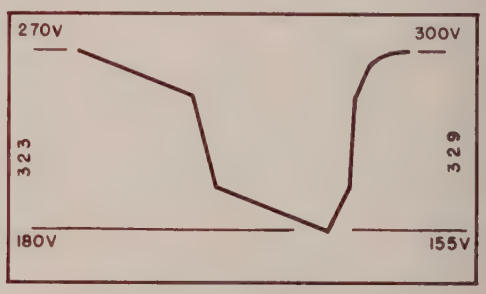
AA. V702-A Cathode, Pin 7



BB. V304 Cathode, Pin 1



CC. V306-B Cathode, Pin 8



DD. V309 Plate, Pin 6 (D1)

FIGURE 4-3. TYPICAL WAVEFORMS

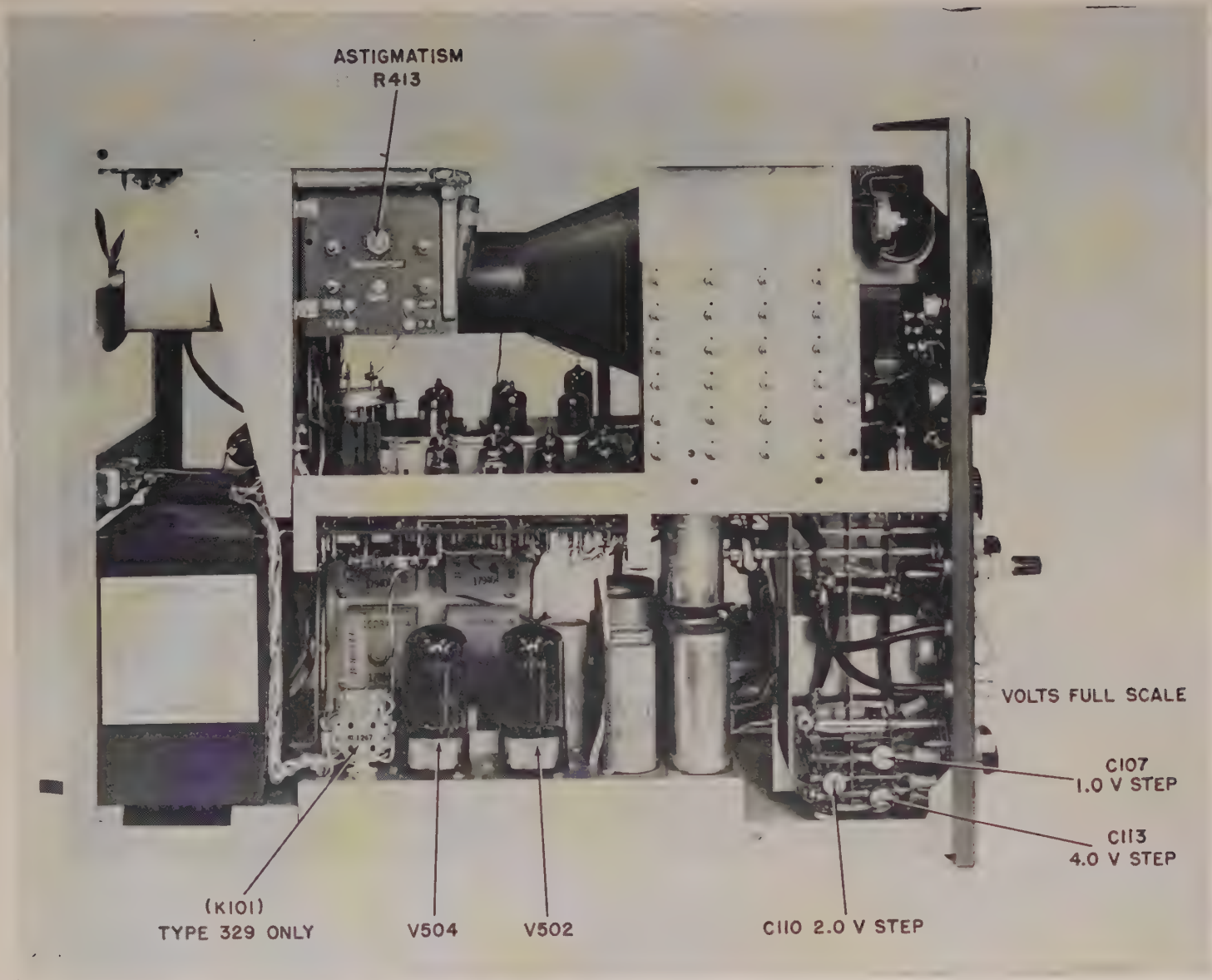


FIGURE 4-4. SERVICE ADJUSTMENTS AND TUBE LOCATIONS, LEFT SIDE

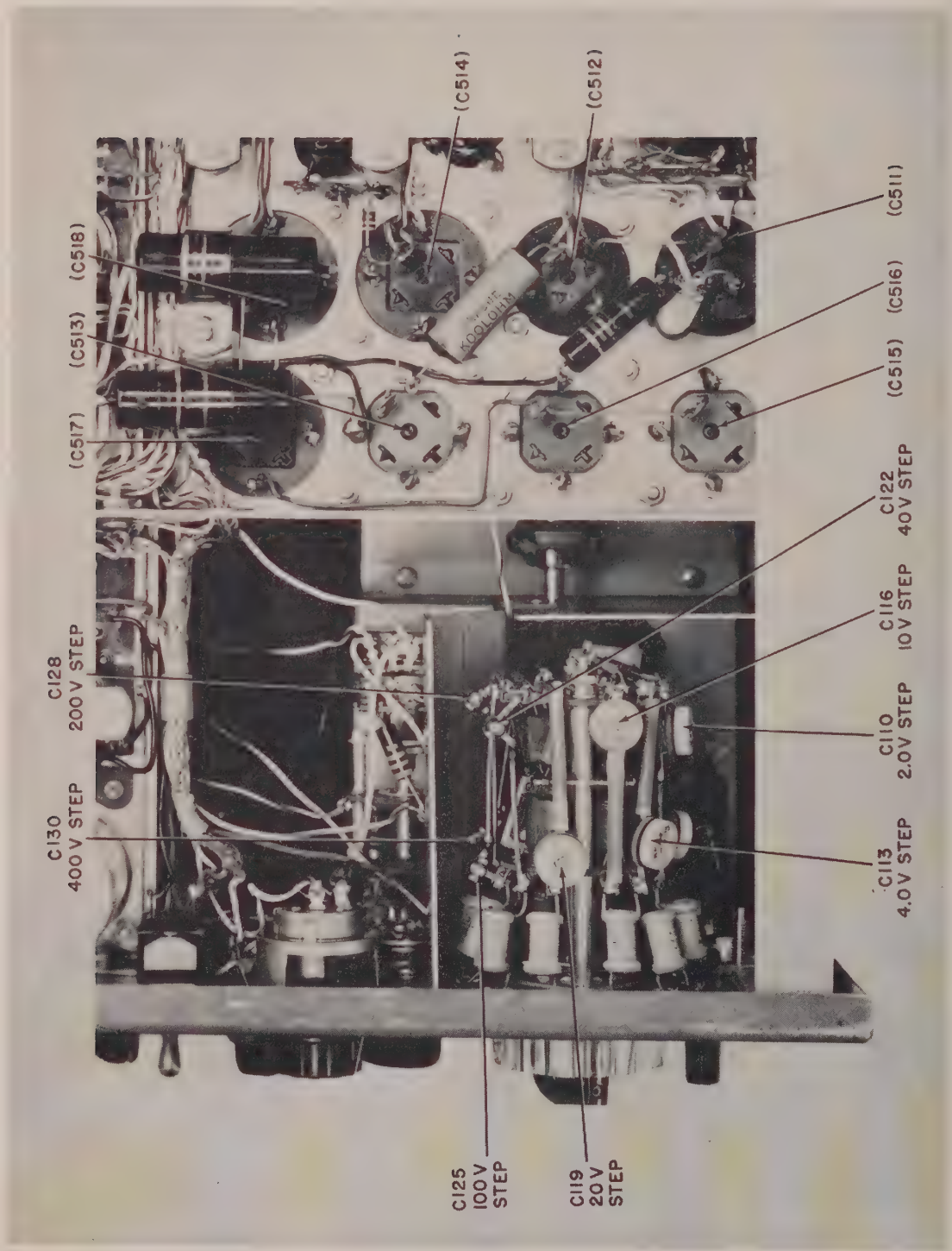


FIGURE 4-5. SERVICE ADJUSTMENTS, VOLTS FULL SCALE SWITCH, BOTTOM

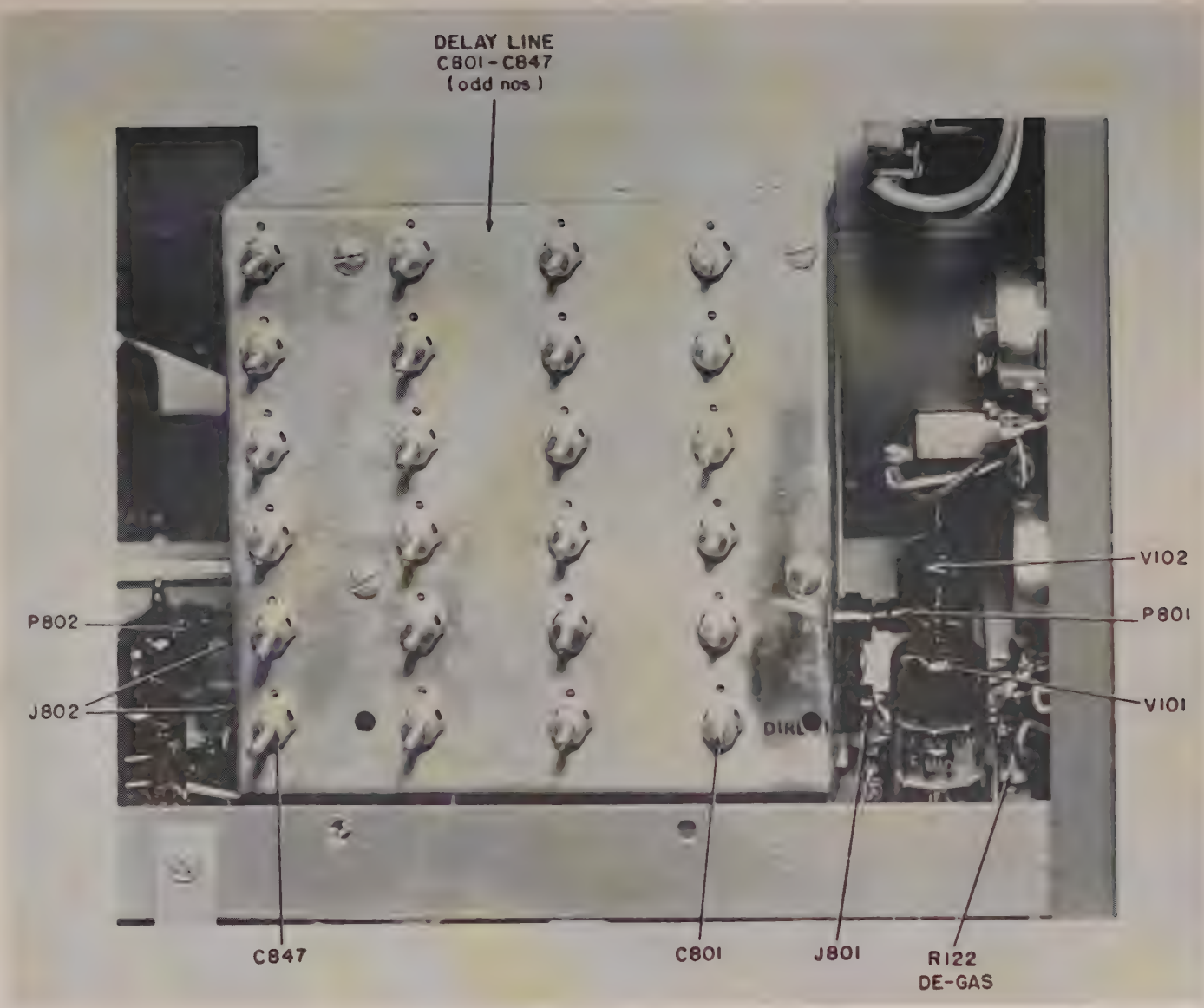


FIGURE 4-6. SERVICE ADJUSTMENTS AND TUBE LOCATIONS, DELAY LINE AND Y PRE-AMPLIFIER

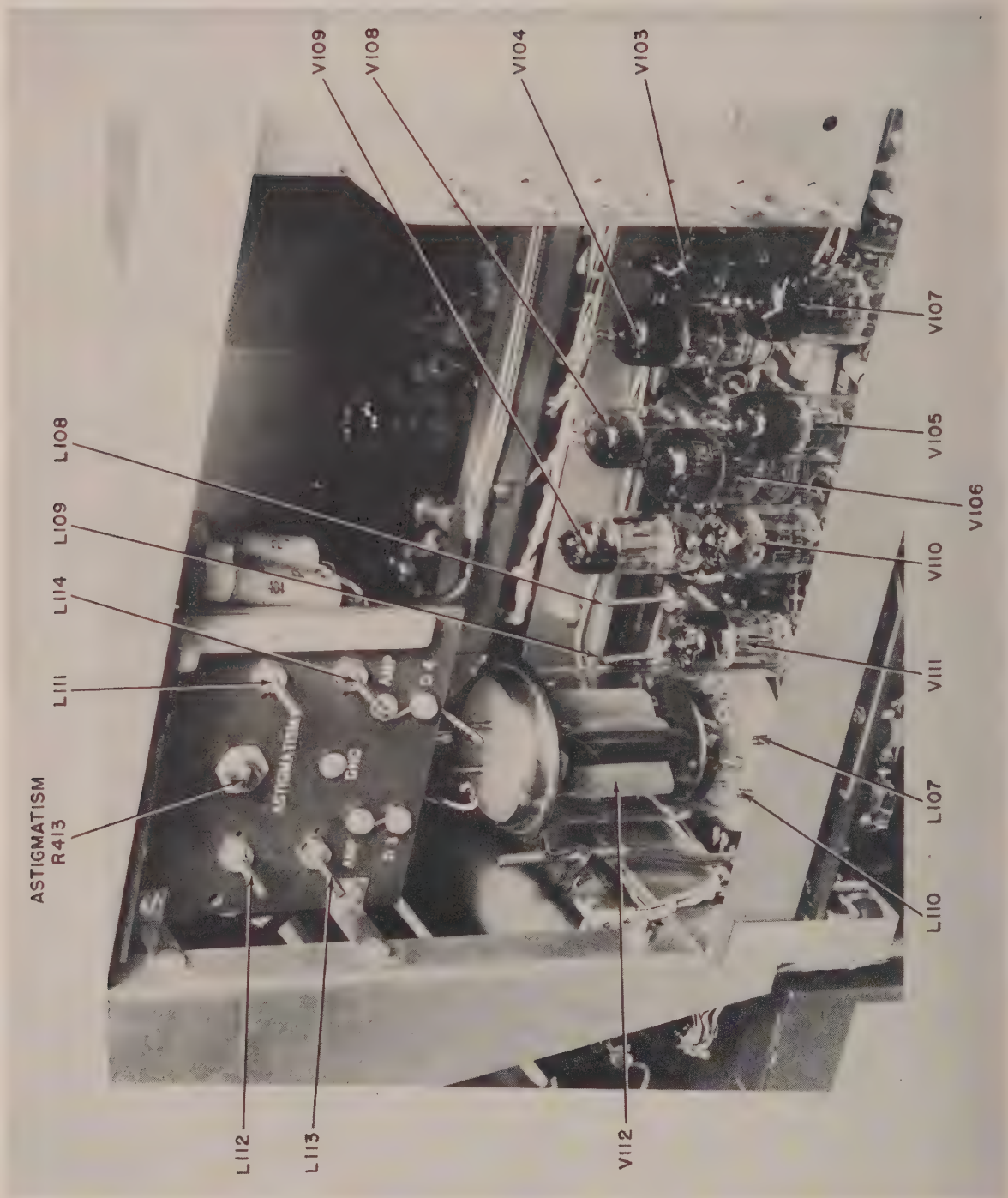


FIGURE 4-7. SERVICE ADJUSTMENTS AND TUBE LOCATIONS, Y AMPLIFIER

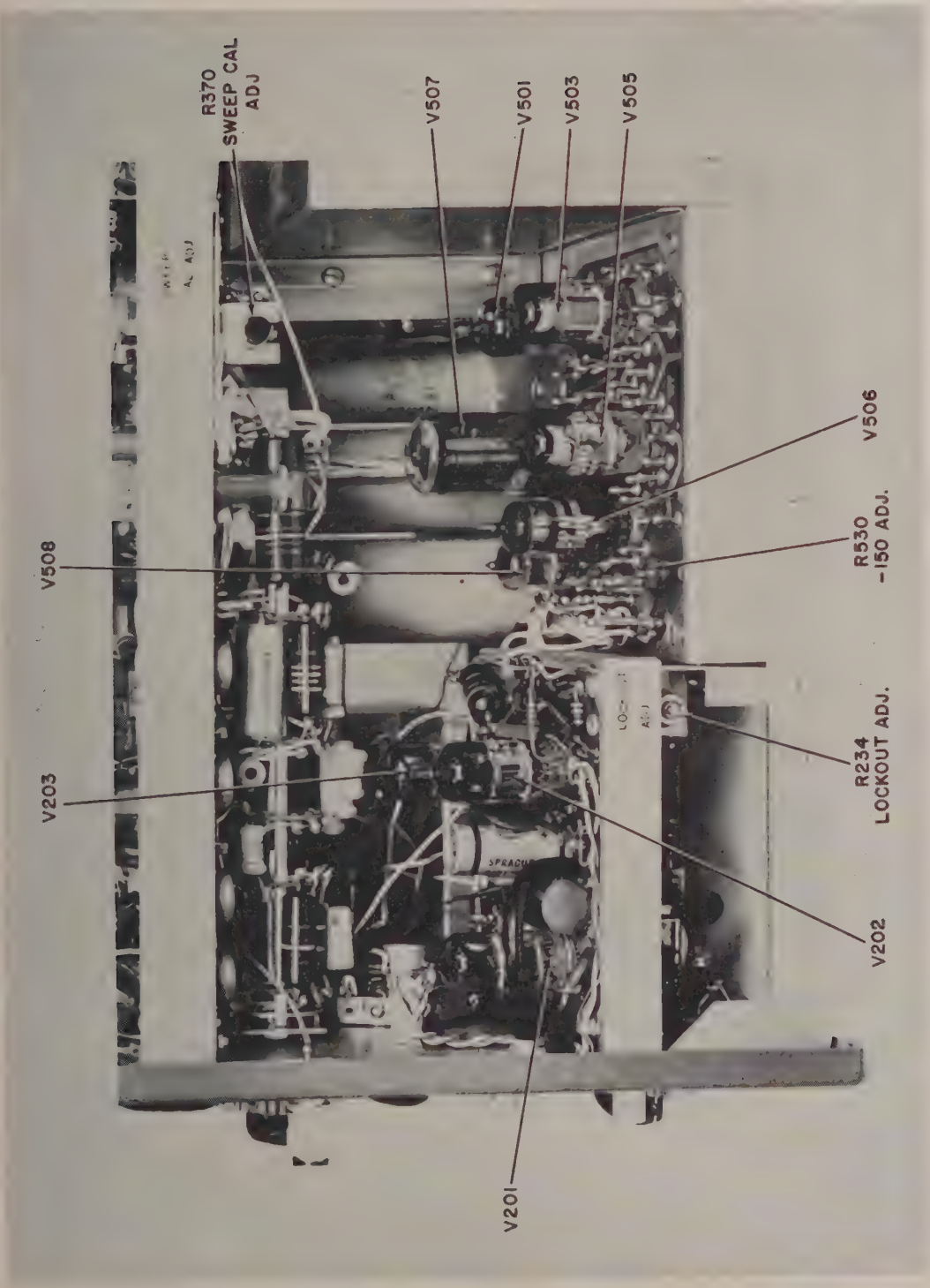


FIGURE 4-8. SERVICE ADJUSTMENTS AND TUBE LOCATIONS, RIGHT SIDE

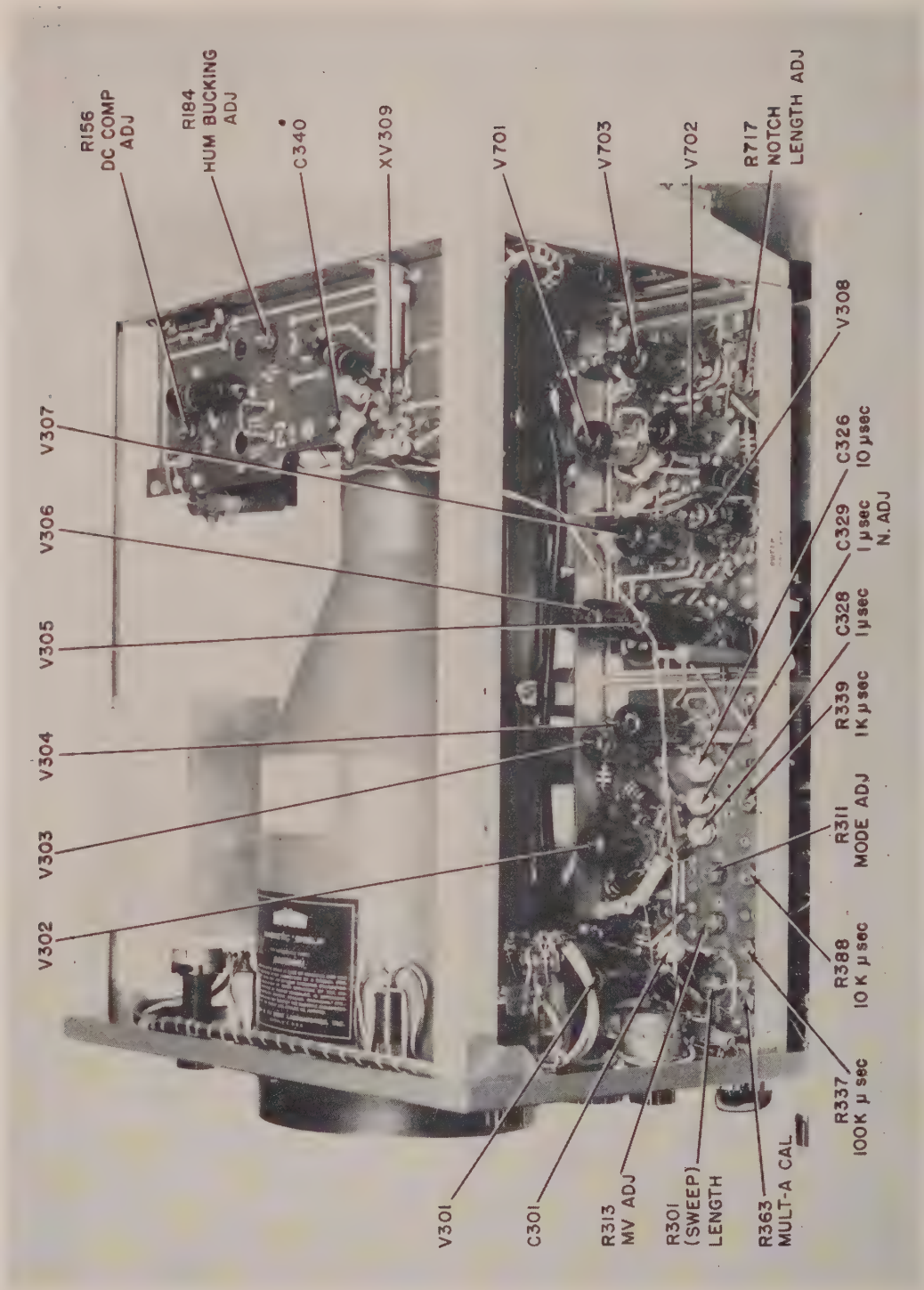


FIGURE 4-9. SERVICE ADJUSTMENTS AND TUBE LOCATIONS, RIGHT-TOP OBLIQUE

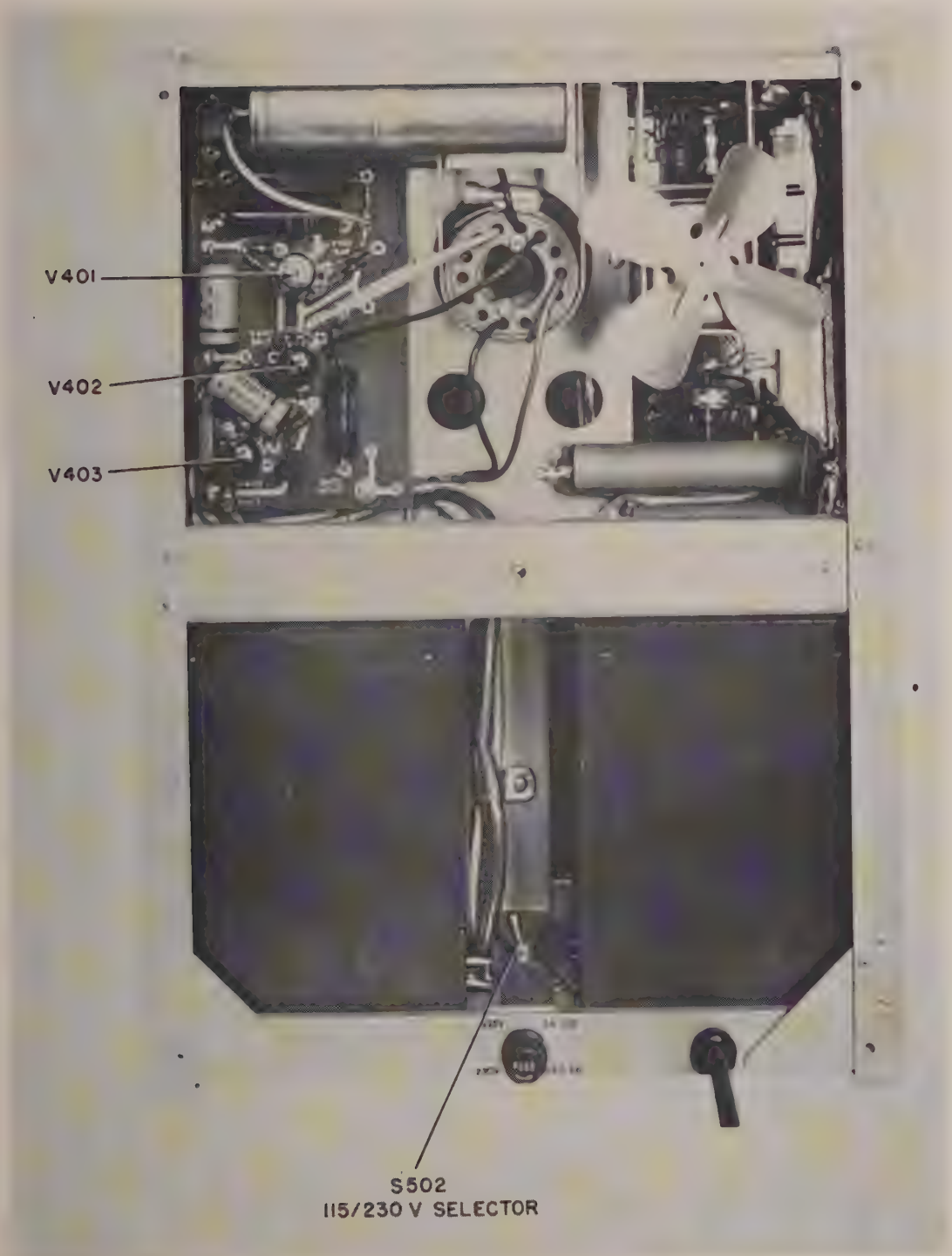


FIGURE 4-10. SERVICE ADJUSTMENTS AND TUBE LOCATIONS, REAR

TABLE 4-2(A)
VOLTAGE AND RESISTANCE MEASUREMENTS
TYPE 329

Preset front-panel controls according to the following chart:
*** Indicates unused tube pin.**

CONTROL	POSITION	CONTROL	POSITION
Y POSITION	To center trace	SYNCHRONIZATION (SELECTOR)	INT
INTENSITY	For normal trace	(AMPLITUDE)	Center of range (0)
Y INPUT SELECTOR	CAL	SWEEP MULT-A	2.5
VOLTS FULL SCALE	0.2	SWEEP MULT-B	10K
Y CAL ADJ	For full scale defl.	NOTCH	OFF
SWEEP MODE	RECUR	NOTCH POSITION	Center of range
MODE ADJ	Fully clockwise	NOTCH RATE	Center of range

TUBE			PIN NUMBERS								
Symbol	Type	Function	1	2	3	4	5	6	7	8	9	CAP
V101	12AT7	Input Cath. Foll	249V	0V	3.4V	37.8V	50.4V	249V	0V	3.4V	*	
			25K	500K	510	45	60	25K	500K	500	*	
V102	12AT7	(A) INT Sync Cath. Foll.	236V	3.4V	6.0V	37.8V	25.2V	249V	2.5V	6.0V	*	
		(B) Y Position Cath. Foll.	28K	560	1.2K	45	30	25K	3.3K	54K	*	
V103	12AT7	Interstage Cath. Foll.	250V	3.4V	5.8V	63V	50.4V	250V	3.4V	5.8V	*	
			25K	50K	750	75	60	25K	530	1.4K	*	
V104	12AW6	½ Cath. Coupled Phase Splitter	5.8V	6.6V	63V	75.6V	62V	130V	6.6V			
			52K	360	75	90	85K	53K	360			
V105	12AW6	½ Cath. Coupled Phase Splitter	5.8V	6.6V	100.8V	88.2V	62V	130V	6.6V			
			1.4K	360	120	105	85K	52K	360			
V106	12AT7	Push-pull Cath. Foll.	250V	61.8V	63V	88.2V	75.6V	250V	61.8V	63V	*	
			25K	85K	5.9K	105	90	26K	85K	6K	*	
V107	12AU7	Cath. Foll. Voltage Regulator	250V	127V	130V	113.4V	100.8V	250V	63.5V	68.5V	*	
			25K	220K	30K	135	120	25K	158K	83K	*	
V108–V111	6485/6AH16K	Push-Pull Driver Ampl.	63V	63.7V	87V	87V	118V	185V	63.7V			
					└6.3 VAC┘							
			6K	3K	123	123	31K	32K	3K			
V112	5894/AX-9903	Push-Pull Amplifier	87V	117V	250V	120V	87V	116V	Tied to Pin 1			D_3 = 345V
			└──────6.3 VAC──────┘									D_4 = 345V
			124	31K	41K	192	123	31K	124			32K

NOTE: 1. All resistance and voltage measurements taken from tube socket to chassis, except as otherwise shown.
2. All voltages are dc and positive with respect to chassis except where otherwise indicated.
3. All voltages measured with a 20,000 ohms/volt meter unless otherwise noted.

TUBE			PIN NUMBERS									
Symbol	Type	Function	1	2	3	4	5	6	7	8	9	CAP
V201	12AT7	(A) INT. Sync Ampl.	137V	6.0V	6.8V	12.6V	25.2V	154V	9.2V VTVM	10.5V	*	
		(B) Sync Phase Splitter	41K	1.2K	960	15	30	44K	2.1M	2.1K	*	
V202	6U8	(A) Sync Ampl.	250V	0V	125V	250V └6.3 VAC┘	250V	109V	1.6V	59V	56V	
		(B) Notch Turn-on Diode Regulator	25K	2K	42K	25K	25K	46K	220	46K	20K	
V203	12AT7	(A) Sync Ampl.	0.35V	–106V	–115V	0V	12.6V	246	0.7V VTVM	3V	*	
		(B) RECUR HI-FREQ. Cath. Foll.	1K	550K	17K	0	15	25K	230K	220K	*	
V301	6U8	(A) Gate Turn-off Ampl.	90V	–86V	0V	–60V └6.3 VAC┘	–60V	–0.5V	–59V	0V	–0.25V	
		(B) ½ GATE Gen.	34K	220K	0	67K	67K	4K	23K	0	33K	
V302	6U8	(A) Gate Cath. Foll.	168V	168V	288V	87V └6.3 VAC┘	87V	400V	170V	0V	–19V	
		(B) ½ Gate Gen.	37K	37K	78K	120	120	42K	16K	0	60K	
V303	6AU6	Sweep Generator	–19V	0V	–60V	–60V └6.3 VAC┘	64V	134V	0V			
			62K	0	67K	67K	2M	44K	0			
V304	12BY7	Saw Cath. Foll.	73V	64V	73V	Tied to Pin 5	87V └6.3 VAC┘	87V	400V	209V	73V	
			430K	2.1M	430K	120	120	120	42K	48K	430K	
V305	12BY7	Saw Assist	–140V	–142V	–140V	Tied to Pin 5	–60V └6.3 VAC┘	–60V	54V	0V	–140V	
			7.8K	4.8K	7.8K	67K	67K	67K	440K	0	7.8K	
V306	6U8	(A) Screen Cath. Foll.	420V	206V	420V	250V └6.3 VAC┘	250V	420V	209V	206V	203V	
		(B) Saw Series Regulator	42K	470K	42K	26K	26K	42K	48K	470K	480K	
V307	6U8	(A) Saw Regulator Ampl.	420V	158V	206V	88V └6.3 VAC┘	88V	203V	160V	171V	167V	
		(B) Gate Voltage Regulator	42K	600K	470K	120	120	480K	500K	32K	220K	
V308	5651	Saw Regulator Voltage Reference		73V		73V	160V		73V			
				430K		430K	500K		430K			
V309	6CL6	Sweep Inverter	0V	–5.7V	225V	87V └6.3 VAC┘	87V	225V	0V	225V	–5.7V	
			0	550K	30K	122	122	410K	0	30K	550K	

TABLE 4-2(A) (Continued)

Voltage and resistance measurements for the beam gate circuit (V401, V402, V403) which follow are made with respect to Pin 7 of V401. Two sets of readings are listed: Condition (1) with the sweep operating as described at the head of this table and Condition (2) with DRIVEN sweep and no sync signal applied.

WARNING!!

USE EXTREME CAUTION WHEN MAKING THESE VOLTAGE MEASUREMENTS. NEGATIVE HIGH VOLTAGE (−5775V) EXISTS BETWEEN ALL POINTS AND GROUND. USE WELL INSULATED TEST PROBES.

TUBE			PIN NUMBERS									
Symbol	Type	Function	1	2	3	4	5	6	7	8	9	CAP
V401	6J6	Beam Gate Generator		Condition (1)		130V	3V	└6.3 VAC┘		0.05V	−22V	0V
				Condition (2)		3V 215K	93V 215K	└6.3 VAC┘		−41V 600K	0.05V 400K	0V 0
V402	6AL5	Beam Gate Limiter		Condition (1)		0.05V		└6.3 VAC┘				−45V
				Condition (2)		−41V 600K		└6.3 VAC┘				−41V 18K
V403	6AL5	Beam Gate Rectifier		Condition (1)		155V	−155V	└6.3 VAC┘		120V RMS RF		120V RMS RF
				Condition (2)		140V 85K	−140V 57K	└6.3 VAC┘	VAC	110V RMS RF ∞		110 RMS RF ∞
V501	6U8	(A) +420 Regulator Ampl.	240V	−2.8V	65V	87V └6.3 VAC┘	87V	330V	0V	100V	110V	
		(B) —HV Regulator Cath. Foll.	29K	1M	42K	118	118	500K	0	100K	240K	
V502	6080	+420 Series Regulator	330V	580V	420V	330V	580V	420V	250V └6.3 VAC┘	250V		
			500K	43K	42K	500K	43K	42K	26K	26K		
V503	6U8	(A) +250 Regulator Ampl.	55V	−2.1V	67V	87V └6.3 VAC┘	87V	205V	0V	0V	−2.2V	
		(B) — HV Regulator Ampl.	240K	740K	29K	118	118	470K	0	0	240K	
V504	6080	+250 Series Regulator	205V	370V	250V	205V	370V	250V └6.3 VAC┘	+250V	+250V		
			470K	27K	26K	470K	27K	26K	120	120		
V505	6U8	(A) — 150 Regulator Ampl.	−2V	−65V	0V	−60V └6.3 VAC┘	−60V	−18V	−63V	−150V	−155V	
		(B) —HV Regulator Ampl.	240K	380K	0	67K	67K	710K	160K	7.3K	2.2M	
V506	5651	—150 Regulator Voltage Reference		−150V		−150V	−63V		−150V			
				7.4K		7.4K	165K		7.4K			
V507	6AU5	—150 Shunt Regulator	−18V	−60V └6.3 VAC┘	0V		95V		−60V	188V		
			710K	75K	0	710K	4.9K		75K	360K		
V508	6AL5	Amplitude Calibrator	−57V	−57V	−60V └6.3 VAC┘	−60V	0V		−150V			
			185K	185K	68K	68K	0		7.4K			

TUBE			PIN NUMBERS									
Symbol	Type	Function	1	2	3	4	5	6	7	8	9	CAP
V601	6AU5	R.F.H.V. Oscillator	Do not Meas	−60V	0V		Do Not Meas		−60V	100V		
					6.3 VAC							
			360K	75K	0		42K		75K	100K		
V602	1X2A	High-voltage Rectifier	H.V. RF do not measure Observe heater for correct glow									−5800V
V701	6BC7	(A) Notch Turn-on	76V	−150V	73V	257V	257V	73V	73V	73V	250V	
						6.3 VAC						
		(B) Saw Coupling (C) Notch Turn-off	∞	7.4K	420K	25K	25K	550	420K	540	26K	
V702	6U8	(A) Notch Cath. Foll.	250V	73V	209V	87V	87V	420V	76V	124V	120V	
						6.3 VAC						
		(B) Notch Turn-off Diode Regulator	25K	11K	48K	120	120	41K	∞	35K	580K	
V703	6U8	(A) Notch Assist	0V	−147V	0V	−60V	−60V	76V	−145V	−59V	−60V	
						6.3 VAC						
		(B) Gate Turn-off Cath. Foll.	0	47K	0	67K	67K	∞	7.7K	22K	75K	

TUBE			PIN NUMBERS (Base)						NECK CONTACTS				
Symbol	Type	Function	1	2	3	5	9	14	A_2	D_1	D_2	D_3	D_4
V404	5ATP	Cathode-ray Tube	−5775V	−5574V	−5805V	−5455V	−5415V	−5775V	345V	225V	225V	345V	345V
					6.3 VAC								
			85M	85M	85.5M	80M	85M	85M	30K	30K	500K	31K	31K

TABLE 4-2(B)
VOLTAGE AND RESISTANCE MEASUREMENTS
TYPE 323

Present front-panel controls according to the following chart:
*** Indicates unused tube pin.**

CONTROL	POSITION	CONTROL	POSITION
Y POSITION	To center trace	Synchronization (Selector)	INT
INTENSITY	For normal trace	(AMPLITUDE)	Center of range (0)
Y INPUT SELECTOR	CAL	SWEEP MULT-A	2.5
VOLTS FULL SCALE	0.2	SWEEP MULT-B	10K
Y CAL ADJ	For full scale defl.	NOTCH	OFF
SWEEP MODE	RECUR	NOTCH POSITION	Center of range
MODE ADJ	Fully clockwise	NOTCH RATE	Center of range

TUBE			PIN NUMBERS									
Symbol	Type	Function	1	2	3	4	5	6	7	8	9	CAP
V101	12AT7	Input Cath. Foll.	249V	0V	3.4V	37.8V	50.4V	249V	0V	3.4V	*	
			25K	500K	500	45	60	25K	500K	500	*	
V102	12AT7	(A) INT Sync Cath. Foll.	236V	3.4V	6.0V	37.8V	25.2V	249V	2.5V	6.0V	*	
		(B) Y Position Cath. Foll.	28K	560	1.2K	45	30	25K	3.3K	54K	*	

TABLE 4-2(B) (Continued)

TUBE			PIN NUMBERS									
Symbol	Type	Function	1	2	3	4	5	6	7	8	9	CAP
V103	12AT7	Inter Stage Cath. Foll.	250V	3.4V	5.8V	63V	50.4V	250V	3.4V	5.8V.	*	
			25K	50K	750	75	60	25K	530	1.4K	*	
V104	12AW6	½ Cath. Coupled Phase Splitter	5.8V	6.6V	63V	75.6V	62V	130V	6.6V			
			52K	360	75	90	85K	53K	360			
V105	12AW6	½ Cath. Coupled Phase Splitter	5.8V	6.6V	100.8V	88.2V	62V	130V	6.6V			
			1.4K	360	120	105	85K	52K	360			
V106	12AT7	Push-Pull Cath. Foll.	250V	61.8V	63V	88.2V	75.6	250V	61.8V	63V	*	
			25K	85K	5.9K	105	90	26K	85K	6K	*	
V107	12AU7	Cath. Foll. Voltage Regulator	250V	127V	130V	113.4V	100.8V	250V	63.5V	68.5V	*	
			25K	220K	30K	135	120	25K	158K	83K	*	
V108–V111	6485/6AHGK	Push-pull Driver Ampl.	63V	63.7V	87V	87V	118V	185V	63.7V			
						└6.3 VAC						
			6K	3K	123	123	31K	32K	3K			
V112	5894/AX-9903	Push-pull Amplifier	87V	117V	273V	120V	87V	116V	Tied to Pin 1			D_s= 225V
			└──6.3 VAC──┘									D'= 225V
			12K	31K	41K	192	123	31K	124			32K
V201	12AT7	(A) INT. Sync Ampl.	137V	6.0V	6.8V	12.6V	25.2V	154V	9.2V VTVM	10.5V	*	
		(B) Sync Phase Splitter	41K	1.2K	960	15	30	44K	2.1M	2.1K	*	
V202	6U8	(A) Sync Ampl.	250V	0V	125V	250V	250V	109V	1.6V	40V	32V	
						└6.3 VAC┘						
		(B) Notch Turn-on Diode Regulator	25K	2K	42K	25K	25K	46K	220	46K	20K	
V203	12AT7	(A) Sync Ampl.	0.35V	–106V	–115V	0V	12.6V	246	0.7V VTVM	3V	*	
		(B) RECUR HI-FREQ Cath. Foll.	1K	550K	17K	0	15	25K	230K	220K	*	
V301	6U8	(A) Gate Turn-off Ampl.	90V	–77V	0V	–60V	–60V	–0.5V	–59V	0V	–0.25V	
						└6.3 VAC┘						
		(B) ½ Gate Gen.	34K	220K	0	67K	67K	4K	23K	0	33K	
V302	6U8	(A) Gate Cath. Foll.	168V	168V	288V	87V	87V	400V	170V	0V	–19V	
						└6.3 VAC┘						
		(B) ½ Gate Gen.	37K	37K	78K	120	120	42K	16K	0	60K	

NOTE: 1. All resistance and voltage measurements taken from tube socket to chassis, except as otherwise shown.
2. All voltages are dc and positive with respect to chassis except where otherwise indicated.
3. All voltages measured with a 20,000 ohms/volt meter unless otherwise noted.

TUBE			PIN NUMBERS									
Symbol	Type	Function	1	2	3	4	5	6	7	8	9	CAP
V303	6AU6	Sweep Generator	–19V	0V	–60V	–60V	50V	134V	0V			
					└6.3 VAC┘							
			62K	0	67K	67K	2M	44K	0			
V304	12BY7	Saw Cath. Foll.	54V	50V	54V	Tied to Pin 5	87V	87V	400V	220V	54V	
							└6.3 VAC┘					
			430K	2.1M	430K	120	120	120	42K	48K	430K	
V305	12BY7	Saw Assist	–140V	–142V	–140V	Tied to Pin 5	–60V	–60V	54V	0V	–140V	
							└6.3 VAC┘					
			7.8K	4.8K	7.8K	67K	67K	67K	440K	0	7.8K	
V306	6U8	(A) Screen Cath. Foll.	420V	217V	420V	250V	250V	420V	220V	217V	214V	
						└6.3 VAC ┘						
		(B) Saw Series Regulator	42K	470K	42K	26K	26K	42K	48K	470K	480K	
V307	6U8	(A) Saw Regulator Ampl.	420V	140V	217V	88V	88V	214V	141V	171V	167V	
						└6.3 VAC┘						
		(B) Gate Voltage Regulator	42K	600K	470K	120	120	480K	500K	32K	220K	
V308	5651	Saw Regulator Voltage Reference		54V		54V	141V		54V			
				430K		430K	500K		430K			
V309	6CL6	Sweep Inverter	0V	–5.7V	225V	87V	87V	225V	0V	225V	–5.7V	
						└6.3 VAC┘						
			0	550K	30K	122	122	410K	0	30K	550K	

Voltage and resistance measurements for the beam gate circuit (V401, V402, V403) which follow are made with respect to Pin 7 of V401. Two sets of readings are listed: Condition (1) with the sweep operating as described at the head of this table and Condition (2) with DRIVEN sweep and no sync signal applied.

Warning!

USE EXTREME CAUTION WHEN MAKING THESE VOLTAGE MEASUREMENTS. NEGATIVE HIGH VOLTAGE (–2275V) EXISTS BETWEEN ALL POINTS AND GROUND. USE WELL INSULATED TEST PROBES.

V401	6J6	Beam Gate Generator	Condition (1)	130V	3V	└6.3 VAC┘		0.05V	–22V	0V
			Condition (2)	3V	93V	└6.3 VAC┘		–41V	0.05V	0V
				215K	215K			600K	400K	0
V402	6AL5	Beam Gate Limiter	Condition (1)	0.05V		└6.3 VAC┘				–45V
			Condition (2)	–41V		└6.3 VAC┘				–41V
				600K						18K
V403	6AL5	Beam Gate Rectifier	Condition (1)	155V	–155V	└6.3 VAC┘		120V RMS RF		120V RMS RF
			Condition (2)	140V	–140V	└6.3 VAC┘		110V RMS RF		110 RMS RF
				85K	57K			∞		∞

TUBE			PIN NUMBERS									
Symbol	Type	Function	1	2	3	4	5	6	7	8	9	CAP
V501	6U8	(A) +420 Regulator Ampl.	240V	−2.8V	65V	87V	87V	330V	0V	45V	55V	
						└6.3 VAC ┘						
		(B) —HV Regulator Cath. Foll.	29K	1M	42K	118	118	500K	0	100K	240K	
V502	6080	+420 Series Regulator	330V	580V	420V	330V	580V	420V	250V	250V		
									└6.3 VAC ┘			
			500K	43K	42K	500K	43K	42K	26K	26K		
V503	6U8	(A) +250 Regulator Ampl.	55V	−2.1V	67V	87V	87V	205V	0V	0V	−2.2V	
						└6.3 VAC						
		(B) —HV Regulator Ampl.	240K	740K	29K	118	118	470K	0	0	240K	
V504	6080	+250 Series Regulator	205V	370V	250V	205V	370V	250V	+250V	+250V		
								└6.3 VAC ┘				
			470K	27K	26K	470K	27K	26K	120	120		
V505	6U8	(A) —150 Regulator Ampl.	−2V	−65V	0V	−60V	−60V	−18V	−63V	−150V	−155V	
						└6.3 VAC ┘						
		(B) —HV Regulator Ampl.	240K	380K	0	67K	67K	710K	160K	7.3K	2.2M	
V506	5651	—150 Regulator Voltage Reference		−150V		−150V	−63V		−150V			
				7.4K		7.4K	165K		7.4K			
V507	6AU5	—150 Shunt Regulator	−18V	−60V	0V		95V		−60V	188V		
				└		—6.3 VAC—			┘			
			710K	75K	0	710K	4.9K		75K	360K		
V508	6AL5	Amplitude Calibrator	−57V	−57V	−60V	−60V	0V		−150V			
					└6.3 VAC ┘							
			185K	185K	68K	68K	0		7.4K			
V601	6AU5	RF HV Oscillator	Do not Meas.	−60V	0V		Do Not Meas.		−60V	45V		
						—6.3 VAC—			┘			
			150K	75K	0		42K		75K	100K		
V602	1X2A	High-voltage Rectifier	HV RF do not measure. Observe heater for correct glow.									−2280V
V701	6BC7	(A) Notch Turn-on	57V	−150V	54V	257V	257V	54V	54V	54V	250V	
						└6.3 VAC ┘						
		(B) Saw Coupling										
		(C) Notch Turn-off	∞	7.4K	420K	25K	25K	550	420K	540	26K	
V702	6U8	(A) Notch Cath. Foll.	250V	54V	220V	87V	87V	420V	57V	95V	90V	
						└6.3 VAC ┘						
		(B) Notch Turn-off Diode Regulator	25K	11K	48K	120	120	41K	∞	35K	580K	
V703	6U8	(A) Notch Assist	0V	−147V	0V	−60V	−60V	57V	−145V	−59V	−60V	
						└6.3 VAC ┘						
		(B) Gate Turn-off Cath. Foll.	0	47K	0	67K	67K	∞	7.7K	22K	75K	

Symbol	Type	Function	PIN NUMBERS (Base) 1	2	3	5	9	14	NECK CONTACTS A_2	D_1	D_2	D_3	D_4
V404	5AMP–	Cathode-ray Tube	–2275V	–2275V	–2305V	–2085V		–2275V	225V	225V	225V	225V	225V
			6.3 VAC										
			12M	12M	12.5M	11M		12M	50K	30K	500K	32K	32K

TABLE 4-3
ADJUSTMENTS TO BE MADE WHEN REPLACING TUBES

NOTE: In some cases the adjustments may need to be reset after about 72 hours of operation upon tube replacement. The Table below indicates which adjustments should be reset at that time.

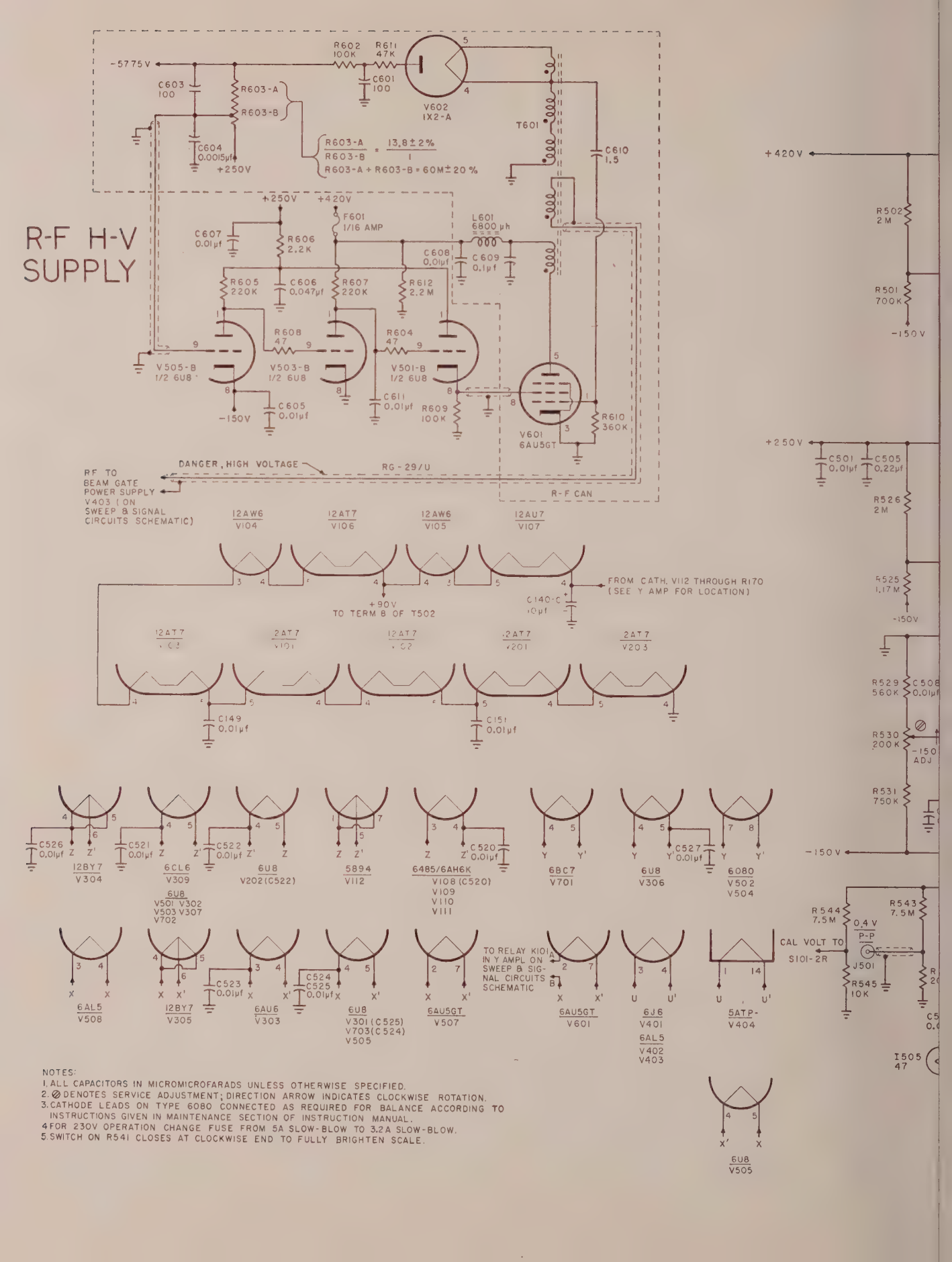
Tubes not shown require no readjustment upon replacement

Tube Reference Symbol	Tube Type	Service Adjustments	Reset After 1st 72 hours
Y AMPLIFIER			
V101	12AT7	DE-GAS (R122), Y D-C BAL, Y POS BAL	Yes
V102 and V103	12AT7	Y D-C BAL, Y POS BAL	No
V104 and V105	12AW6	Y D-C BAL, Y POS BAL D-C COMP ADJ (R156)	No No
V106	12AT7	Y D-C BAL, Y POS BAL	No
V108, V109, V110, V111	6485/6AH6K	HUM BUCKING ADJ (R184) D-C COMP ADJ (R156)	No No
V112	5894/AX9903	HUM BUCKING ADJ (R184) D-C COMP ADJ (R156)	No No
SYNC CIRCUIT			
V203	12AT7	LOCKOUT ADJ (R234) Resistor Tap for RECUR HI-FREQ	No No
GATE AND SWEEP CIRCUITS			
V301	6U8	MODE (R311)	Yes
V302	6U8	MODE (R311)	Yes
V304	12BY7	MULT-A CAL (R363)	Yes
V308	5651	SWEEP CAL ADJ (R370)	No
BEAM GATE AND CRT CIRCUITS			
V404	5AMP– 5ATP–	SWEEP CAL ADJ (R370), ASTIGMATISM (R413), LENGTH (R301) Focus control and CRT screen bleeder jumpers (329 only)	No
LOW-VOLTAGE POWER SUPPLY			
V505	6U8	–150 ADJ (R530), SWEEP CAL ADJ (R370)	No
V502 and V504	6080	Cathode tap	No
V506	5651	–150 ADJ (R530)	No

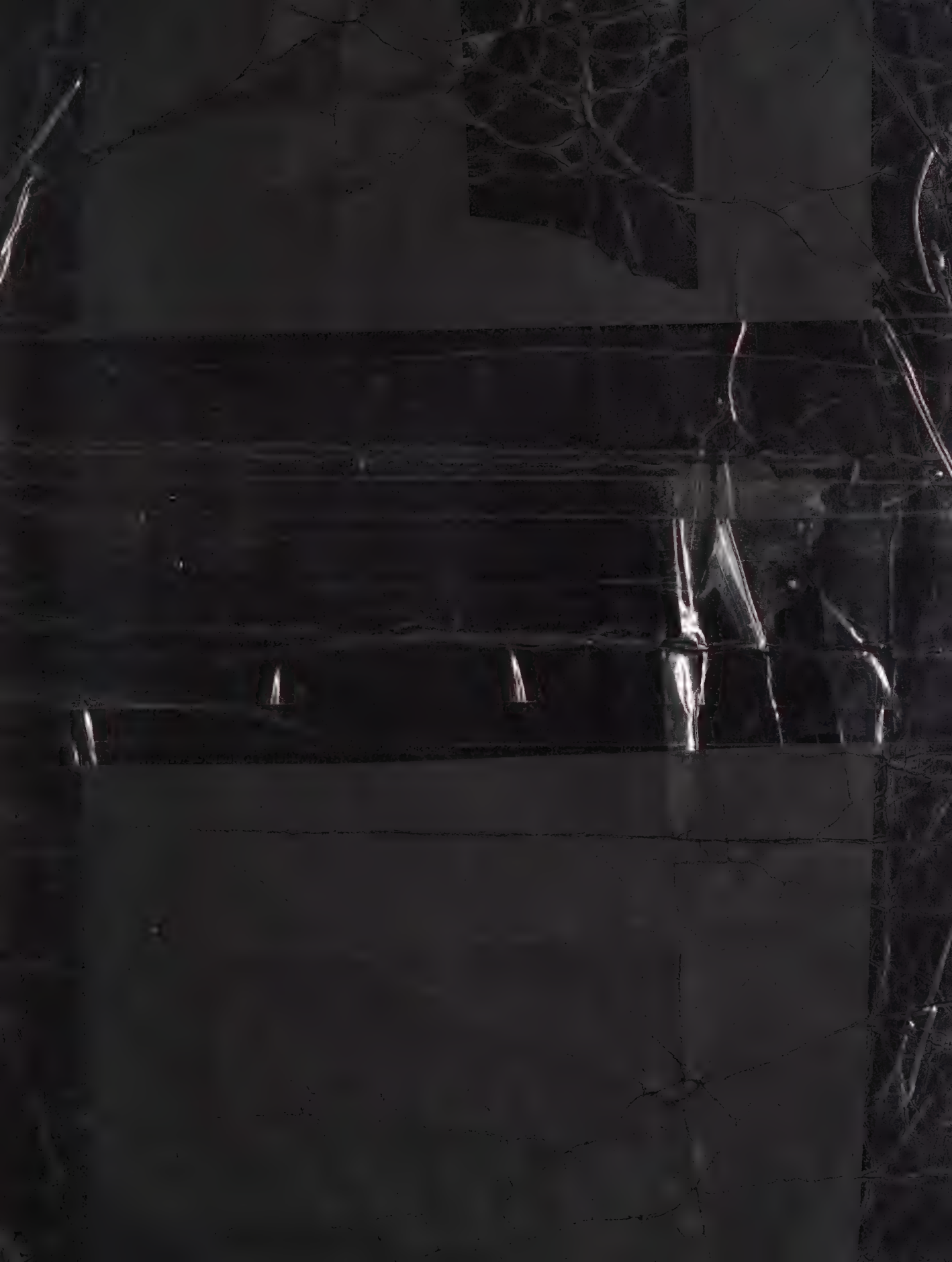
—NOTES—

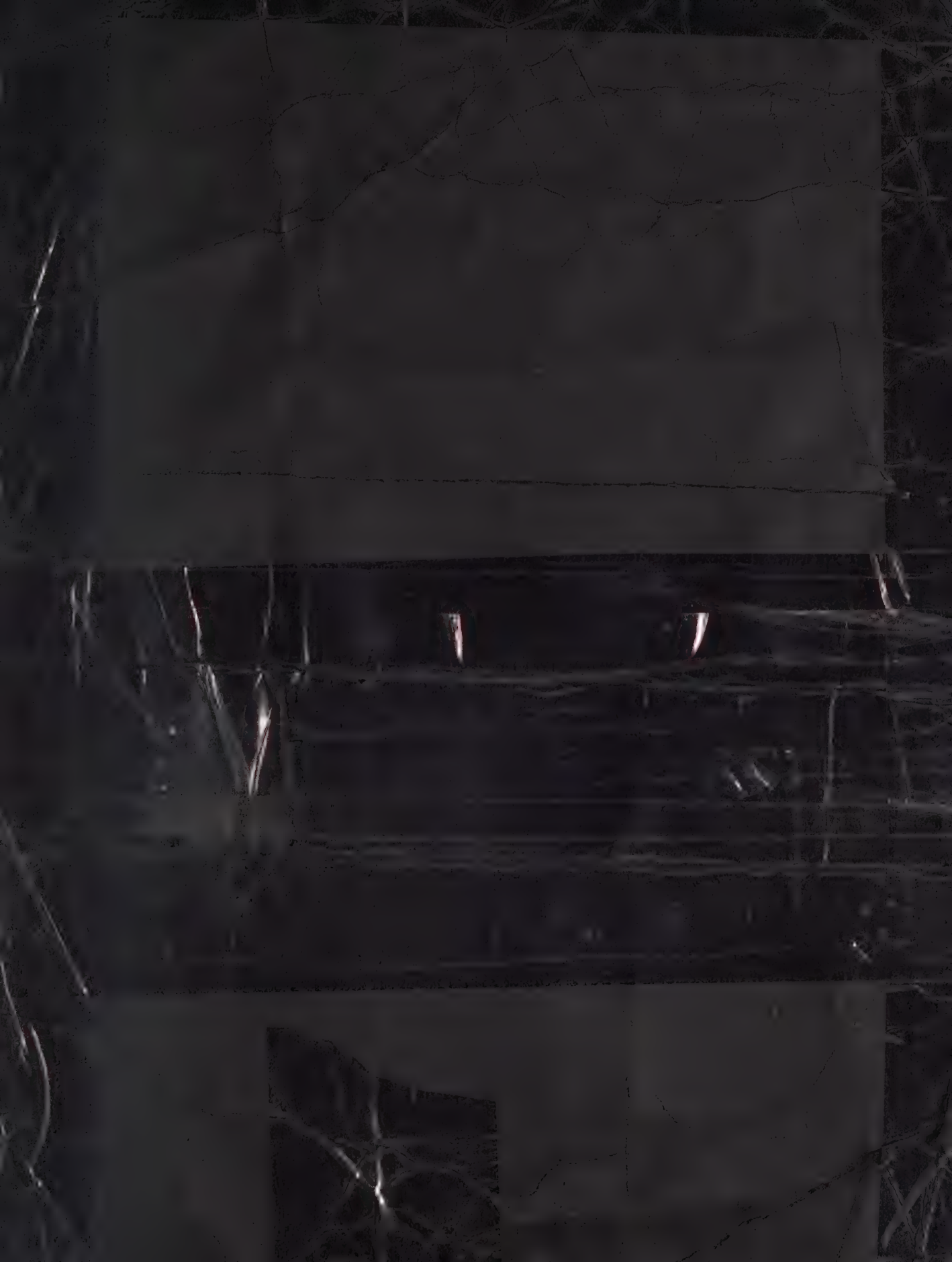
— NOTES —

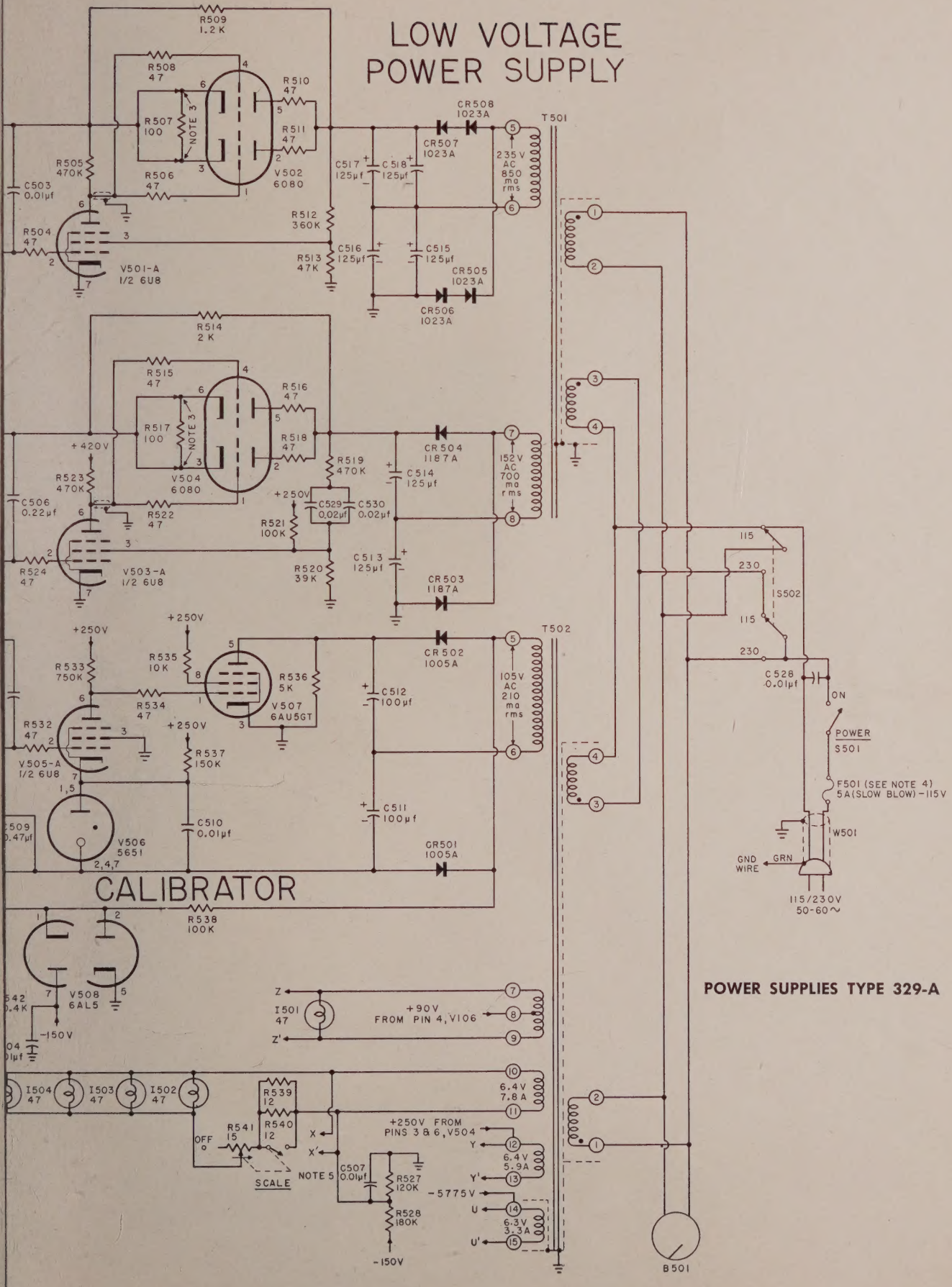
—NOTES—



NOTES:
1. ALL CAPACITORS IN MICROMICROFARADS UNLESS OTHERWISE SPECIFIED.
2. ⊘ DENOTES SERVICE ADJUSTMENT; DIRECTION ARROW INDICATES CLOCKWISE ROTATION.
3. CATHODE LEADS ON TYPE 6080 CONNECTED AS REQUIRED FOR BALANCE ACCORDING TO INSTRUCTIONS GIVEN IN MAINTENANCE SECTION OF INSTRUCTION MANUAL.
4. FOR 230V OPERATION CHANGE FUSE FROM 5A SLOW-BLOW TO 3.2A SLOW-BLOW.
5. SWITCH ON R541 CLOSES AT CLOCKWISE END TO FULLY BRIGHTEN SCALE.






LOW VOLTAGE
POWER SUPPLY
CALIBRATOR
R509 1.2K
R508 47
R507 100
NOTE 3
R510 47
R511 47
R505 470K
R506 47
V502 6080
C503 0.01µf
R504 47
V501-A 1/2 6U8
R512 360K
R513 47K
C516 125µf
C517 125µf
C518 125µf
C515 125µf
CR508 1023A
CR507 1023A
CR505 1023A
CR506 1023A
235 V AC 850 ma rms
T501
R514 2K
R515 47
R516 47
R517 100
R518 47
V504 6080
+420V
R523 470K
C506 0.22µf
R522 47
R524 47
V503-A 1/2 6U8
R519 470K
C514 125µf
+250V
C529 0.02µf
C530 0.02µf
R521 100K
R520 39K
C513 125µf
CR504 1187A
CR503 1187A
152V AC 700 ma rms
+250V
R535 10K
R536 5K
V507 6AU5GT
R533 750K
R534 47
R532 47
V505-A 1/2 6U8
R537 150K
C510 0.01µf
C512 100µf
C511 100µf
CR502 1005A
GR501 1005A
105V AC 210 ma rms
T502
R538 100K
V508 6AL5
-150V
Z
Z'
I501 47
+90V FROM PIN 4, V106
I504 47
I503 47
I502 47
R539 12
R540 12
R541 15
OFF
SCALE
X
X'
NOTE 5
C507 0.01µf
R527 120K
R528 180K
-150V
+250V FROM PINS 3 & 6, V504
6.4V 7.8A
6.4V 5.9A
-5775V
6.3V 3.3A
Y
Y'
U
U'
115
230
S502
C528 0.01µf
ON
POWER S501
F501 (SEE NOTE 4) 5A(SLOW BLOW) - 115V
W501
GND WIRE
GRN
115/230V 50-60~
B501
POWER SUPPLIES TYPE 329-A

WARRANTY AND SERVICE NOTICE
for
Industrial Type Cathode-ray Tubes and Instruments

DU MONT INSTRUMENTS

Each instrument manufactured by the Instrument Division of Allen B. Du Mont Laboratories, Inc., is guaranteed to equal or exceed its published performance specifications. It is further guaranteed against defective materials (other than the cathode-ray tube) and workmanship for a period of one year from date of delivery. Any defective instrument or an instrument that does not meet or exceed our specifications will, upon inspection by us, be repaired or replaced at our discretion should such defect appear within the guarantee period.

To register this guarantee, the enclosed guarantee card must be properly filled out and mailed to the factory immediately upon receipt of the equipment. Complete information is necessary. BOTH THE TYPE NUMBER AND THE SERIAL NUMBER OF THE INSTRUMENT MUST BE GIVEN ON THIS CARD.

Instruments must be examined immediately upon receipt, since claims for damage in transit will not be honored by the carrier unless prompt action is taken.

DU MONT CATHODE-RAY TUBES

Industrial type cathode-ray tubes manufactured by Allen B. Du Mont Laboratories, Inc., are guaranteed for 1000 hours of operation or for a six-month period of installation, whichever shall first expire. The right is reserved, however, to limit claims to a period of nine months after shipment from the factory. Adjustments will be made on the merit of each individual claim because of the widely varying applications to which such tubes are subjected, and a tube which becomes defective during the guarantee period will be replaced ONLY AFTER INSPECTION AT THE FACTORY. Cathode-ray tubes which are sent in under the guarantee, must be sent with transportation paid.

BURNED OUT HEATERS AND BROKEN GLASS ARE NOT COVERED BY THE TUBE GUARANTEE

To register a tube guarantee, the guarantee card enclosed with the tube must be properly filled out and mailed to the factory immediately upon receipt of the equipment. Complete information is necessary. TYPE NUMBER AND SERIAL NUMBER OF THE CATHODE-RAY TUBE MUST BE INCLUDED. The serial number of the tube will be found either on the glass stem of the electro-gun structure or on the bulb near the Du Mont brand. Tubes must be examined immediately upon receipt, since claims for damage in transit will not be honored by the carrier unless prompt action is taken.

CHANGES IN SPECIFICATIONS

The right is reserved to change the published specifications of equipment at any time and to furnish merchandise in accordance with current specifications without incurring any liability to modify equipment previously sold, or to supply new equipment in accordance with earlier specifications excepting under the classification of special apparatus.

SERVICE

In order to insure factory service under our guarantees, the guarantee cards enclosed with all instruments and tubes must be properly filled out and returned. In all cases where service or adjustment is requested, please write first to the factory giving complete information concerning the nature of the failure and describing the manner in which the equipment was used when failure occurred. THE TYPE NUMBER AND SERIAL NUMBER of the equipment must also be given. In this way, much time can be saved and unnecessary inconvenience often avoided. When writing in this respect, address:

Allen B. Du Mont Laboratories, Inc.
Instrument Service Department
760 Bloomfield Avenue, Clifton, New Jersey

The Instrument Service Department will then send to the customer, the written procedure for sending the instrument back to the factory. All equipment should be packed and shipped in accordance with this procedure; and identification tags should be attached to each tube or instrument.

REPLACEMENT PARTS

If it is necessary to order a replacement component from the factory, always give the type number and serial number of the instrument and refer to the component by its symbol designation and description on the circuit schematic. This will help to expedite service.

DU MONT

Additional copies of this manual may be secured at a cost of two dollars each or twenty dollars per dozen copies; postpaid in the United States of America only.

Allen B. Du Mont Laboratories, Inc.

Instrument Division

760 BLOOMFIELD AVENUE, CLIFTON, NEW JERSEY